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LONDON SHOW REVIEW 1951

AUTOMOBILE ENGINEER

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AUTOMOBILE ENGINEER

Design, Materials, Production Methods, and Works Equipment

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THE LONDON MOTOR SHOW

THIS year the ordinary Show visitor has inevitably found the display a little unexciting. There are very many causes for this, apart from the one that has always operated since the war, namely, the non-availability of cars to the English user. This tendency to a decline of public interest is largely attributable to the fact that, with the exception of certain foreign cars, only one really new model is shown. For all practical purposes, therefore, most British motorists have seen the Show before.

The Jaguar XK120 coupe is, perhaps, the outstanding new vehicle externally, although this is, of course, based upon the now world-famous sports two-seater. A striking newcomer that is a new design throughout and forms the centre of popular interest is the Austin Seven. It is a very handsome little vehicle and embodies the excellent design standards associated with this maker. Even so, a single vehicle alone can hardly be expected to sustain public interest, and there was still probably insufficient vehicle novelty at the Show to maintain public attendance at the level of previous Shows. As usual, closer and more expert inspection disclosed a good deal that is of technical interest to the designer.

Rubber Suspension Joints

To quote one feature, for example, there is a marked trend towards an increased use of rubber in front suspensions. As practical experience of this medium in service grows, designers feel increasing confidence and make bolder use of this type of joint. Moreover, the experience of the firms specializing in the design and supply of such parts widens daily, and even in the past twelve months very considerable progress has been made.

This applies not only numerically in the matter of fresh applications but in the techniques relating to design, production and materials. Unfortunately, as a background to the entire Show, there is the menacing shadow of armament manufacture. Only those who have had to work with this spectre at their elbow really know the full, calamitous effects. To the general public it manifests itself merely as one more burden operating as another setback to car deliveries and a further lowering of living standards.

The designer is more deeply concerned and is shackled in the very routine of his everyday job. Already in most organizations the era of substitute materials is well advanced, although even in this there is no stability. At any time material specifications may be again altered and in this respect, designs must presumably remain in a state of flux. In production, the hold-up has made its unwelcome appearance in full force; material shortages being in evidence in all directions, even in many of the substitute materials.

Conditions, then, in the industry are not encouraging from the design point of view. Problems and difficulties have been created even in the ordinary course of car production. Development of new designs, therefore, may have to await the arrival of more propitious times.

Avoiding Design Checks

Nevertheless, it is, perhaps, more essential than ever that designers have a free hand and are actively engaged in the development of new schemes, because if and when the armament drive ceases, the British motor industry will find it is in a world flooded with excess productive capacity, and competition must be expected to be correspondingly severe.

This state of affairs lends added importance to the need for avoiding, as far as possible, any check on design and development, and it is on this account that the present static period is much to be regretted. The pressure of competition in Europe as well as in overseas markets will be increased by the rapid and ever growing rehabilitation of the German industry, and France also has a rising output of vehicles of all kinds.

At the moment, America still remains a largely unknown quantity, and much depends upon how soon the stupendous factory system turns from the output of arms to the production of civilian goods, more particularly road vehicles, and particularly cars.

In specialized vehicles of the sports type the British automobile industry may well be satisfied with the position it has secured. This is particularly true of one maker who supplies an outstanding machine at a very modest figure. This car may be relied upon to hold this particular market for some years yet. In the small and medium class also, there should be a place for British vehicles for some time to come. Most of the European competitors are at present still rather high in price, but as and when the American industry decides to enter the various markets

there is no doubt that a very considerable problem will arise.

In many of our overseas markets, it is the medium-sized, all-purpose vehicle that is really in demand, and it is here that the American car offers so much more for so little initial outlay. British designers should, therefore, now be at work on this type of universal vehicle. Actually the basis of such vehicles already exists, so that work should more particularly be in hand on the evolution of a two-pedal, automatic or semi-automatic transmission for machines of this type. Several of our designs as they stand would be quite suitable as regards power, suspension, silence and reliability, provided the gear change, as we know it, were replaced by something more in line with what world motoring markets will be likely to demand.

Reliable reports from a series of widely distributed markets all point to this conclusion. If, therefore, we can originate a "gearless" control of low cost and simplicity, there is little doubt that competition could be effectively met and much of the present world market retained. At present, even with our extremely simple, synchromesh gearboxes, buyers in certain markets appear to find difficulty in driving our cars, more particularly where they have had experience of American products.

Luxury Vehicles

In cars of the true luxury class, it may well be that the British industry will retain a good hold on world markets for a long time to come. In vehicles of the very highest class and in high-grade, custom bodywork, the Show has indicated that British craftsmen are still doing very fine work indeed. In this connection, there has been much misinformed comment regarding what is probably one of the most outstanding bodies produced in recent years. This is the large Daimler saloon, resplendent with gold-plate and black coachwork. By any standard this is a most magnificent production. Neither is the charge of flamboyancy really quite justified, as the car still retains a quiet dignity which is in sharp contrast with other designs of the somewhat freak type, emanating from Continental coachbuilders aiming at the same objective, namely a striking, and outstanding effect. Striking the Daimler vehicle certainly is, but it still retains a great measure of refinement and dignity and it is a work of value to the British industry from the publicity point of view. On this account it fully justifies itself, quite apart from its intrinsic merits.

It can, of course, be rightly argued that the gold finish externally, and more particularly on the bumpers, is a very unpractical feature. Nothing could be more unsuited to take the knocks and calamities of town traffic than gold plating. Here, perhaps, designers have missed an opportunity, because had the centre portions of the bumpers carried a rubber insert, those parts of the vehicle would have been more practical. A black rubber would conform to the main colour scheme of the vehicle and seem to be an additional inducement to use this type of construction. A small framing of gold surrounding the black rubber bumper would have carried through this keynote and at the same time modified the effect of flamboyance while introducing a note of practicality and making for a much more serviceable finish.

In this particular connection, the whole question of bumper finish may rightly be criticized. After all, nothing is more unsuited to blows and ill treatment than any type of plating. As soon as a bumper receives a knock the plating is damaged and an opening for rust is created. From the practical aspect, therefore, all bumpers should be rubber-surfaced, and in no uncertain fashion. A really robust surface should be presented and a finish of this kind would in most cases improve the appearance of the vehicle. Where colours other than black are demanded, suitable rubber mixtures could be made up. After all, the bumper is at no time an improvement to the appearance of a vehicle, and the less obtrusive it is in appearance the less the line of the vehicle is interfered with. A further advantage would be economy in production and a great reduction in the demand for scarce materials.

Detail Advances

As will be gathered from the detailed design studies in other pages of this issue, the Show, which apparently seemed "flat" to the general onlooker, did in fact embody a great deal of mechanical advance. A considerable amount of detail improvement has taken place during the past year. Most of this work has centred upon securing greater reliability, durability, silence, and general refinement. One point, however, that seems to have escaped the notice of designers generally is that the car heater is, in fact, an integral part of the engine cooling system. If these quite considerable heat extractors are superimposed on already over-adequate engine radiator systems, excessive over-cooling results.

Many years ago, the Research Department of the then Institution of Automobile Engineers confirmed by research and experiment that over-cooling was one of the

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Some Outstanding New Designs by British Manufacturers.

main sources of engine destruction. Reports, which followed as a result of some years of very close research, left no doubt on this point whatsoever. Fuel consumption is, of course, also very adversely affected when engines are run below optimum temperature.

Over-Cooling

Bearing in mind that the majority of modern cars are over-cooled, even in summer in temperate climates, the normal cooling arrangements become quite excessive in winter. To this unsatisfactory state of affairs is now added further considerable cooling, set up by the radiator of the car heater. This, of course, is put into operation at the very worst possible period, namely in the coldest weather.

If the car owner has sufficient knowledge to blank off large areas of the radiator, engine conditions can be rendered tolerable. This does, nevertheless, constitute an incredible crudity, and the unsightliness of these slabs of material needs no comment. Even the average radiator muff is no decoration to a vehicle upon which the stylist has lavished such care. Admittedly, in some cases it is possible to get the blanking-off piece behind the grille. Alternatively, a sheet of Perspex can be used and this much reduces the disfigurement. In the main, however, being a temporary measure, the roughest methods are employed. Right in the front, therefore, of a machine designed to be the acme of elegance and precision, a slab of cardboard or three-ply wood is affixed. Unfortunately, owners who realize the need for these precautions are in the minority. Many cars, therefore, are run at destructive temperatures during the winter, and this condition will become more common as the heater is more generally employed.

A Sound Scheme

On the Renault 750 c.c. rear-engined car, on the other hand, there is a full realization by the designer of engine requirements. Attached to the bottom of the radiator is a spring blind which can be adjusted to various requirements according to the prevailing temperatures of the day. A water-temperature gauge is fitted on the dash so that visual indication is given and the cooling capacity can readily be adjusted to maintain an optimum running temperature.

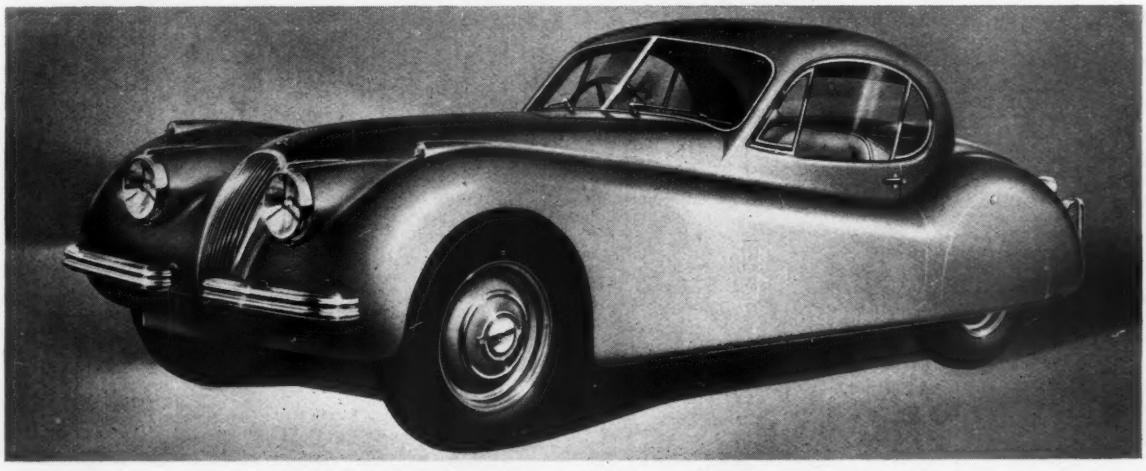
A further refinement in this connection on this particular vehicle is the provision of shrouds that are attached adjacent to the fan in cold weather, and which, in conjunction with the fan, direct the heated air from the radiator into the body. This scheme would seem to be the solitary example of intelligent handling of the matter, not only in the recent Show but generally in the world of vehicle design and manufacture. It seems the more remarkable, therefore, that producers of far more ambitious vehicles neglect the matter entirely. It will be understood, of course, that these comments refer to cars outside the luxury class. The Rolls-Royce Company, for example, have always been alive to the vital importance of proper running-temperatures and have always given the matter the serious attention that it demands. Other makers have from time to time employed devices of one kind or another to this end. For example, thermostatically controlled shutters have been fitted, although generally, for various reasons, these have been only partially satisfactory.

In fairness, also, to the multitude of makers who neglect the matter altogether, it must be admitted that the minute size of the engine on the Renault car makes heat conservation a more important matter. There is, however, no doubt that in winter and in cold climates much harm is done mechanically and untold quantities of fuel go to waste throught the general failure to deal with the matter really seriously.

The Convertible Body

One of the aspects of the Show that has become more noticeable in recent years is the increasing number of convertible-type bodies exhibited. This is doubtless a reflection of demands by customers in climates where spells of settled fine weather make the open vehicle particularly useful. Many of the newer examples of this body type are attractive in line, practical in execution, and judging by reports, satisfactory in service. Users speak favourably of their durability in the matter of freedom from rattles, and some measure of the credit for this must go to the great improvement in frame designs that has taken place over recent years. One of the drawbacks to this type of body has always been lack of visibility, more particularly at the sides and the rear. This matter has been boldly attacked in the convertible bodywork on the Jensen chassis in which the lower rear portion of the hood consists not of fabric but of a curved Perspex panel that drops into the rear of the body when the hood is folded.

In general, therefore, while there are no revolutionary designs or great mechanical advances to be recorded, the Show as ever, held many minor points of interest to the designer. As will be gathered from the pages that follow, any visitor prepared to take an intelligent interest would not be unduly disappointed.



The new fixed head coupé on the Jaguar XK120 chassis

EARLS COURT EXHIBITION

A Critical Review of Current Design

ENGINES

Modification and Refinement Aimed to Improve Performance and Ensure Longevity

ONCE again, the Motor Show proved the folly of prophecy, especially when applied to the motor industry. It had been generally affirmed that larger engines would be the rule and that no more side-valve engines would be seen. One has only to consider the justly popular Morris Eight to obtain a firm rebuttal of both statements. For a number of years this sturdy little car has, in Great Britain, held its field alone, but now Austin re-enters the small car field with a new edition of the "Seven." This, however, does show a change in that it follows current Austin practice and is powered by an o.h.v. engine.

Consideration of the specifications of other British cars shows that a great number of side-valve engines are still being produced and that they appear to be firmly established in popular favour. According to statistics, 31 per cent of the models available have side valves, but that percentage includes some very popular vehicles.

In actual fact there was little at Earls Court that was absolutely new. In some ways this is all to the good, as it should be remembered that in pre-war days it was fashion and not design which sold motor cars. It took the war to teach us that the cars often discarded after, perhaps, not more than five or six thousand miles in a year's running, were good for a hundred thousand miles, even under conditions of partial neglect. Design was good and so were materials.

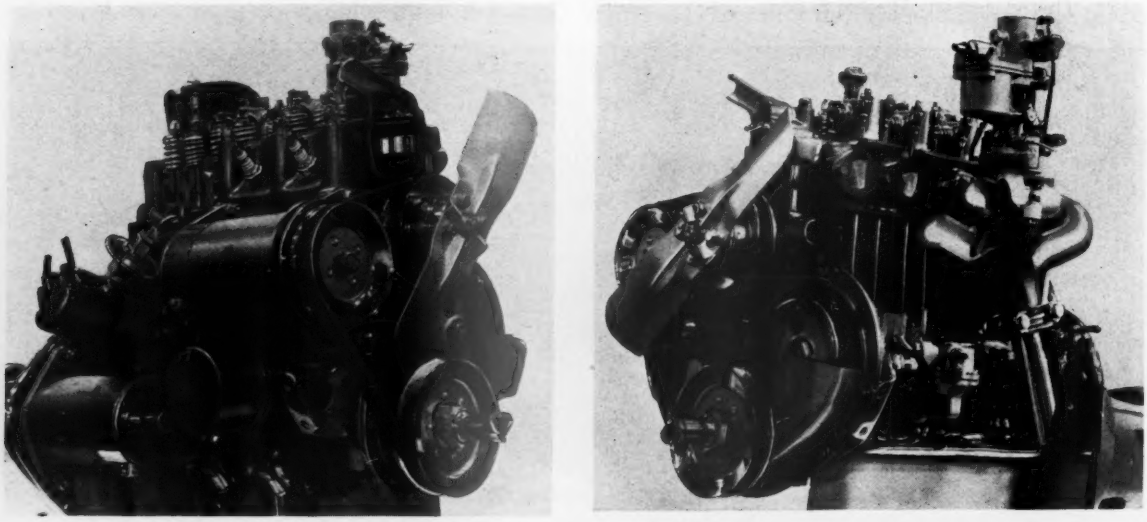
A marked degree of rationalization is becoming apparent, whereby different power engines of a given make use many common components, thus simplifying both manufacturing and servicing. In some respects design moves in cycles. One small item in this connection is the change of piston design in one engine, whereby the piston skirts are made of "equal thickness to obviate distortion." Conversely another manufacturer has recently adopted split-skirt pistons.

Since the London Show is always termed "International," it was good to see a strong foreign contingent. Outstanding was the first appearance, after an absence of thirteen years, of a single German model. At the Paris Salon, it may be noted, there were no fewer than thirteen. However, the Porsche was of considerable interest in that it is powered by a flat-four, air-cooled, rear-mounted engine of modest dimensions. The car has a good power: weight ratio and a very smooth air-flow exterior, and is capable of high speeds.

Engine form and position show little change. In British cars they are almost invariably upright, with cylinders in line and located at the front of the chassis. American design shows a distinct tendency to adopt a V-form for the larger engines.

Jowett employ a water-cooled, flat-four engine located at the front, Porsche an air-cooled, flat-four at the rear, and Panhard an air-cooled, flat-twin at the front. One is tempted to wonder who will first fit a flat engine centrally, under the front seat, so that the whole of the chassis area may be devoted to the accommodation of the occupants and their luggage. In the commercial passenger field, the most modern practice is to turn the engines on their sides and place them under the floor to attain that objective.

Water cooling of automobile engines has come to be accepted as general and indeed almost inevitable. It is therefore both interesting and refreshing to find air-cooling retained on the Dyna Panhard and the German Porsche. On water-cooled units it is now general practice to employ directional cooling. Water is delivered by ducts or pipes fitted within the cylinder head, or within the block in side-valve engines, to such points of maximum heat concentration as the



Right- and left-hand sides of the new Austin Seven engine

valve seats and sparking plug bosses. In the past, pump cooling systems depended to some degree upon natural circulation at the remote ends of the water jackets. This resulted in uneven cooling, a condition best overcome by this directed movement of the coolant.

An interesting comparison of the methods of directing the coolant appears in the two Vauxhall engines. The pump of the six-cylinder unit delivers water from the bottom of the radiator to the full-length cylinder jackets; circulation between the cylinder jackets and the head jackets being by means of cored slots and nozzles fitted in the base of the head. On the four-cylinder engine the pump also draws water from the bottom of the radiator but delivers it to a distribution pipe in the cylinder head There is an increasing tendency to separate the cylinder barrels so that the circulation of water completely around them will ensure a speedy and even withdrawal of heat.

Water pumps are generally of the centrifugal type having a single, open-type impeller on a shaft running on two ball bearings or, in some cases, one double-row bearing. Leakage is commonly obviated by a spring-loaded carbon gland.

Crankshafts are mostly steel forgings, although Ford uses a cast crankshaft. Singer on the "1500" use a Meehanite crankshaft, cast by Qualcast (Ealing Park) Ltd., the three main journals of which have a diameter of 2 in and the pins 1·75 in. Meehanite is frequently dismissed from thought as being merely "superior cast iron." It is, however, a high-duty iron in which the constituent structure has been closely controlled so that, according to its intended usage, it possesses characteristics which give it endurance limits closely comparable with that of steel forgings. Control principles are undergoing development and it is expected that a wider use of the cast crankshaft may result. The cast shaft is employed to a greater extent in the larger types of diesel engine than in the automobile field.

One move conducive to the longevity of engines is the increasing use of full-flow oil filters. It may be noted that an oil cooler, more common on cars of racing type, is fitted on the Jowett Javelin; in this case, in front of the main radiator.

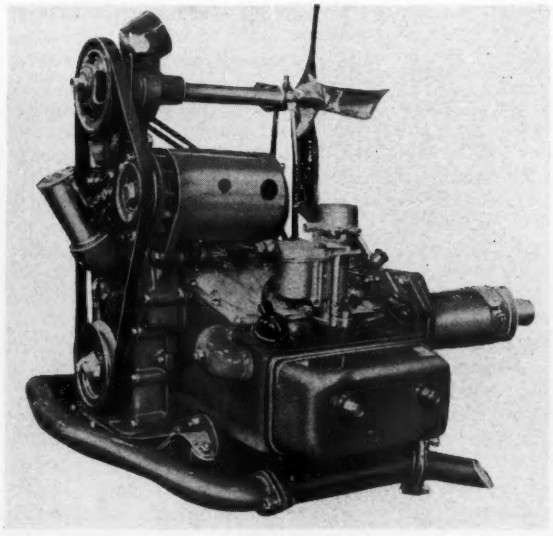
Engine finish externally still leaves much to be desired. It was therefore a pleasure to see the high degree of finish on a few production-type vehicles, including the enamelling of the exhaust manifolds on the Jaguar. There is, as recently discussed in this journal, also a need for improvement in the general silence of engines. Recently much has been done with the aim of eliminating tappet noise. Other noises, especially from overhead valve gear enclosed in light, pressed-steel covers, induction systems and fans, warrant attention.

From 1922 until 1939, the Austin Seven was in continuous production. If memory serves aright it had a four-cylinder, side-valve engine of but 696 c.c., the bore being 56mm. The new Seven is powered by a four-cylinder engine of 800 c.c., bore being 58 mm and stroke 76 mm. It now has overhead valves, employs a compression ratio of 7·2 : 1 and develops 30 b.h.p. at 4,800 r.p.m. Maximum torque output is 40 lb-ft at 2,400 r.p.m.

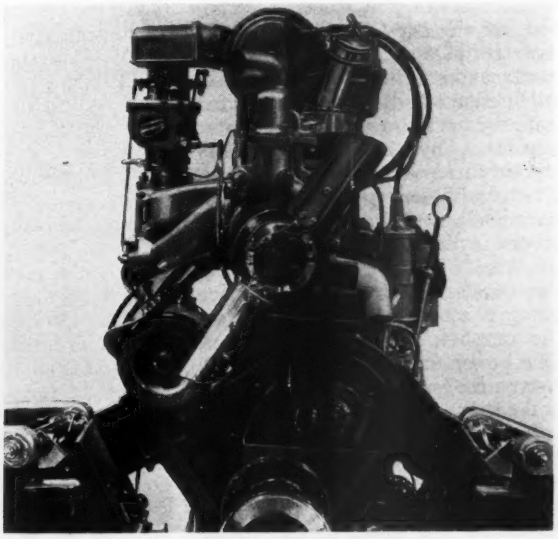
Other than the name "Seven" there is no similarity between the old and the new. The new engine is based on an iron monobloc casting having full-length water jackets. The head is detachable and carries the valves and rocker gear. A tapped boss is provided for a heater connection. The crankshaft is a substantial steel forging and is carried in three large-diameter, white-metalled strip type bearings. Oil feed holes are drilled through to the crankpins. Stamped connecting rods, which have angle-split big-end caps, carry flat-topped, split-skirt, Lo-Ex aluminium alloy pistons, anodized on the exterior. Three compression rings and one scraper ring are fitted above the gudgeon pin which is clamped in the piston.

Positioned low down on the left-hand side of the engine, the forged steel camshaft is carried in three bearings; two being direct in the cylinder casting while at the front is a steel-backed, white-metalled bearing. The camshaft is chain driven and a twin synthetic rubber tensioner is fitted. The tappets are of inverted piston type in which the lower ends of the pushrods seat. At the upper ends of the rods is a screw adjuster of conventional type. In the combustion chamber, positioned towards the right-hand side of the engine, the valves are arranged vertically, in line and seating level. Inlet valves are of silicon-chrome and exhaust valves of XB corrosion resistant steel.

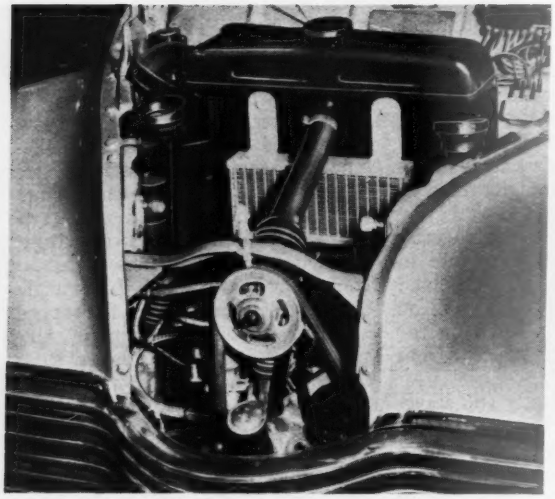
An exceptionally deep pressed-steel sump has a working capacity of 5 pints of oil. Lubrication is effected by means of a co-axial, non-draining type pump mounted on the rear end of the camshaft and drawing oil through a large filter having gauze at sides and bottom. Oil is delivered



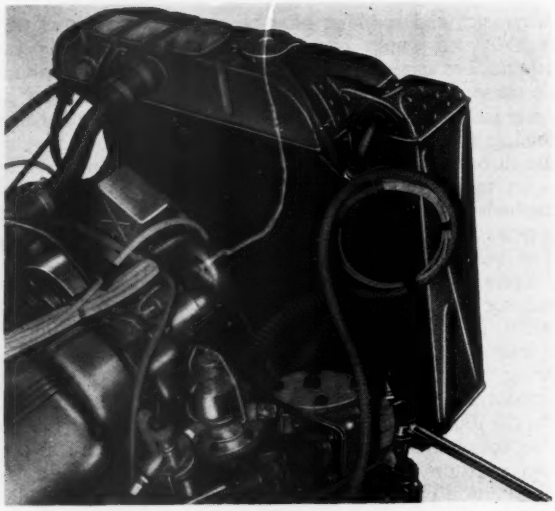
Jowett flat-four engine



Front end of the Sunbeam-Talbot 90 engine



Oil cooler on Jowett Javelin



Ferrari oil cooler

to a gallery on the right-hand side of the crankcase, thence by drilled passages to main, big-end and camshaft bearings. Jet holes are provided in the connecting rods to lubricate the cylinder walls, a feature of particular value when starting up. The front camshaft bearing feeds oil at reduced pressure to the valve rocker gear and to the timing chain. Tappets are lubricated by oil returning from the rocker gear by way of the push rod apertures and also by splash. A readily detachable, by-pass filter mounted on the right-hand side of the engine is connected by drilled passages. The oil filler is conveniently sited on the rocker cover. There is a vent pipe in the tappet cover and a breather in the rocker cover is connected to the air intake silencer.

Cooling water is drawn from the bottom of the radiator by a pump mounted high up on the front of the cylinder block. It is driven, together with the dynamo which is carried on the right side of the engine, by the usual rubber belt. Two-bladed fans are fitted as standard, but four-bladed components are available for export models. A Smith bellows-type thermostat is fitted in the cylinder head. The distributor, positioned almost horizontally on the right-hand side of the cylinder block and towards the rear, is driven by skew gear from the camshaft, and an A.C., Y-type pump is actuated by an eccentric on the camshaft in the usual manner. The power unit is flexibly mounted, V-type rubber pads in shear are used at the front, and at the rear end of the gearbox a rubber ring is fitted in a housing surrounding the rear cover.

The remaining Austin models continue largely unchanged. The 4-litre engine is also fitted to the Jensen Interceptor.

The advent of a new Daimler is always an interesting event and the 3-litre Regency model is certainly no exception. The 2,952 c.c. six-cylinder engine, in many respects, appears to follow the general lines and proportionate dimensions of the 2-litre Lanchester introduced last year. There are no startling new innovations, design following well-proved Daimler traditions. Cylinder block and upper half of the crankcase are cast in one, the bores being fitted with Brivadium dry liners. Cylinder dimensions are 76·2 mm bore and 108 mm stroke.

Particular care has been given to cooling, the cylinder barrels being separated yet as close together as possible in order to keep down the engine length. To the sides of the barrels the water jackets are generous in width. The cylinder head is fairly deep, making possible the provision of generous cooling areas, especially round the valve pockets. This engine is another example of the system which employs directional cooling in the head, leaving the cylinder jackets to be cooled by thermo-siphonic circulation, controlled by a thermostat. The water pump, mounted at the front of the cylinder block, is conventional in type and is belt driven. It is noteworthy that the cylinder head fixing studs are positioned well away from the cylinder bores to reduce the risk of distortion, both in manufacture and later during maintenance.

Machined from an alloy steel forging with integral balance weights, the crankshaft is carried in four steel-backed bearings, 2·5 in diameter, the crankpins being 2·25 in diameter. The stamped steel connecting rods are split diagonally at the big ends and the caps secured by setbolts. The gudgeon pin is clamped in the small end. On the die-cast aluminium-alloy pistons having T-slotted skirts are three narrow compression rings and one oil control ring.

Overhead valves are mounted in line, with their heads over the left-hand side of the bores. They are slightly inclined from the vertical so that an easy gas flow is possible, and also to conform with the sloping roof of the oblong combustion chambers. Operation is by push-rods and rockers and the tappets of chilled cast iron, are of the inverted piston type. A four-bearing camshaft, having wide cams with contours designed for silent operation, is driven by a triple-row chain. All oilways are drilled in the casting; the solitary external connection being the feed to the overhead rocker gear. Full-flow filtration is effected on the pressure side of the lubrication system.

This new 3-litre Daimler engine develops 90 b.h.p. at 4,100 r.p.m. yet delivers its maximum torque output at 1,600 r.p.m. It may be noted that it is considered that the compression ratio of 6·7 : 1 permits good performance on Pool fuels but, additional to the normal automatic control, the distributor is fitted with a manual control to permit adjustment when using higher-grade fuels.

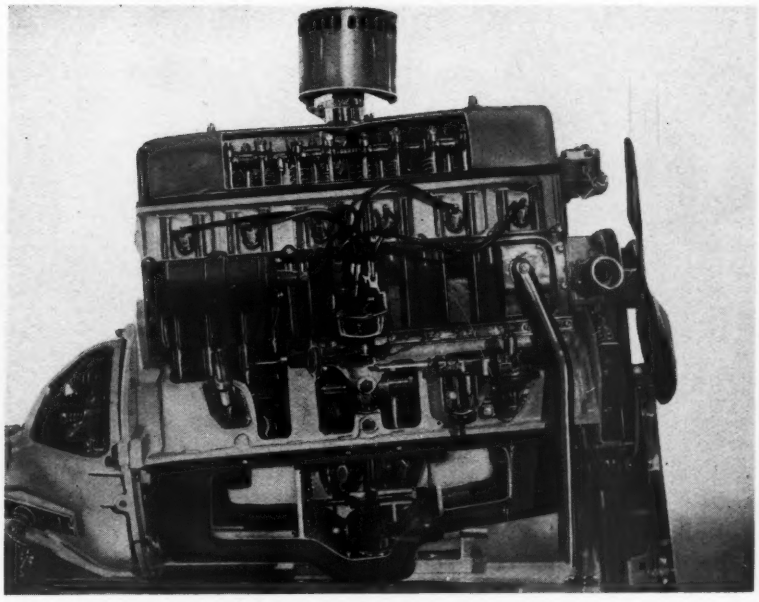
In addition to the 2½-litre models, Daimler also exhibited the car with the largest engine in the Show; the 5½-litre straight-eight of 85·1 mm bore and 120 mm stroke.

While generally unchanged from former models, the engine fitted to the Hillman Minx, Mark V, differs in certain details introduced to promote efficiency and longevity. The 1,265 c.c. four-cylinder engine of 65 mm bore and 95 mm stroke has side valves, employs a compression ratio of 6·63 : 1 and develops 37·5 b.h.p. at 4,200 r.p.m.

The steel crankshaft, forged with integral counterweights, has three journals of 1·75 in diameter and the main bearings are of strip form. One new feature is the use of an aluminium alloy piston that is constant in section throughout the skirt; the aim being to prevent distortion and subsequent excessive wear. Four rings are fitted, the one in the skirt being of the oil control type. The pistons are now tin-plated so that the softer initial bearing between piston and cylinder wall will facilitate the running-in process and ultimately lengthen engine life.

With a view to increasing the oil filtration area to approximately twice that formerly employed, the gauze is now made cup-shape. This has the additional merit, when running under cold conditions, that even if the bottom of the filter is blocked by sludge the sides of the cup will still function. As an additional measure of protection a cowl is provided over the filter element, but ample clearance permits free flow of lubricant. An A.C. breather and filler cap is fitted to export models to increase crankcase ventilation and reduce any tendency to sludging. To accommodate the longer oil filter in the existing form of sump, the pump body has been shortened slightly in depth. Improved engine cooling includes an increase in the pressure limit of the radiator relief valve from 4 to 7 lb/sq in.

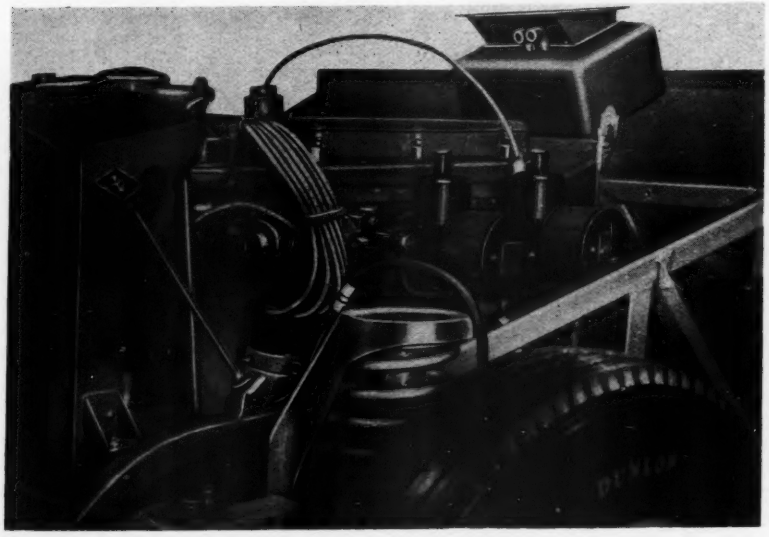
In introducing two new cars based on a common vehicle size, Vauxhall have, nevertheless, retained the two former-type engines; a four-cylinder of 1,442 c.c. and a six-cylinder having a swept volume of 2,275 c.c. A current tendency of manufacturers is to make engines as similar as possible except for the fact that one may have more cylinders than the other. Here the converse applies, as the two engines vary widely in design. Both are alike in that the alloy iron crankcase is cast integrally with the cylinder block. The structure is a rigid one, well stiffened by webs at the main bearing housings. Each has a one-piece crankshaft forged from high tensile steel and carried in shell-type, white-metalled bearings. The four-cylinder engine has three main bearings while the six-cylinder unit has four. It is interesting to note that of these seven bearings no two are alike in diameter or length. There is also a difference in diameter of the crankpins of the two shafts.



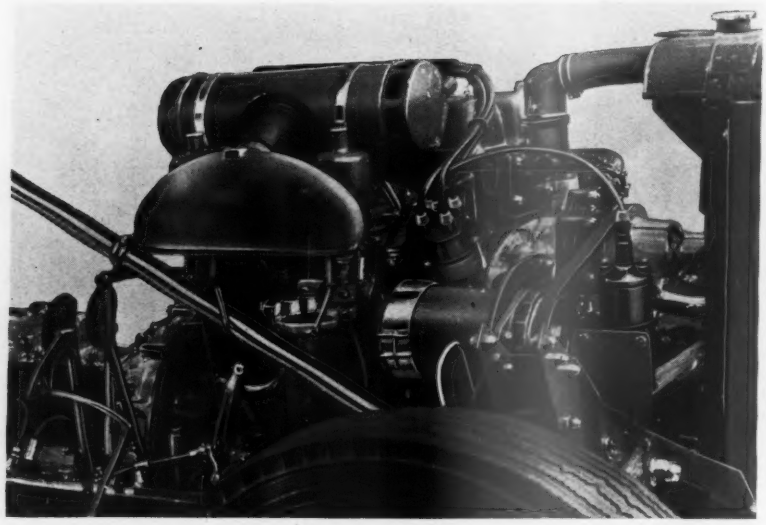
Right side of sectioned Vauxhall Velox engine

The tin-plated, aluminium alloy pistons have split, oval-ground skirts and carry three rings above the gudgeon. The bores of the two engines are identical at 69·5 mm, but the stroke of the four-cylinder engine is 95 mm while that of the other is 100 mm. Piston form, however, differs considerably. The crown of the piston of the four-cylinder is of an inverted and unequal-sided V-form. That for the six-cylinder model is partly flat and then rises slightly towards the right-hand side of the engine, that is, away from the inlet valve position. In each case the raised portion tapers off at front and rear. The somewhat unusual shape of the combustion space resulting is designed to promote smooth running on weak mixtures ignited by wide-gap sparking plugs; features introduced in the search for economical running. Big-ends are split diagonally to enable the connecting rod and piston assemblies to be withdrawn upwards through the bores, an interesting feature being the serration of the joint faces to ensure positive location. The case-hardened gudgeon pins, which are ground and lapped to size, are clamped in the small end of the rods.

The oil sump on the four-cylinder engine is a steel pressing, while that on the larger model is an aluminium die casting. Each is fitted with baffles to prevent surge. Of the differences between the two engines the most interesting is found in the respective valve arrangements. On the four-cylinder engine the valves are disposed



Aston Martin 2½-litre engine



Riley 2½-litre engine in chassis

in line, with a slight inclination of the stems towards the left-hand side, and their seatings are at a common level. On the six-cylinder, inlet valves are inclined to the left and exhaust valves to the right, the exhausts seating in the combustion chamber at a higher level than the inlets.

The four-cylinder engine develops 35 b.h.p. at 3,200 r.p.m. and 71 lb/ft torque at 1,800 r.p.m. while the six-cylinder unit yields 58·3 b.h.p. at 3,500 r.p.m. and 106·5 lb/ft torque at 1,100 r.p.m. A careful study of both engines suggests that the four is of later design than the six, a thought that gains strength from the fairly open secret that a new six, having a lower stroke : bore ratio and giving increased power, is under development and approaching the production stage.

For the first time for many years no V-8 engine was shown by Ford, although it may be noted that V-8 models were exhibited by the American, Canadian and French Ford Companies. Contrary to expectations, however, the Anglia was to be seen in both 8 h.p. and 10 h.p. form. The larger engine, which is the same as that fitted in the Prefect, is used only for export models. Introduced only at the last Show, the 1½-litre Consul and the 2½-litre Zephyr cars are now in full production. They represent a complete departure from former Ford practice in that they both have o.h.v. engines, and the Zephyr has six cylinders. These engines have been designed for ease of production, and interchangeability has been carried as far as possible so that components for either engine can pass through the same production line. The cylinder block and crankcase is an integral casting in which the skirt is carried well below crankshaft level. Water jacketing is carried the full length of the cylinder barrels, each of which is separated from its neighbour by a generous passage.

In accordance with Ford practice the crankshaft is a casting, carried in three main bearings on the Consul and four on the Zephyr. In either case they are mounted in thin-wall, white-metalled bearings. The camshaft, mounted on the right-hand side of the crankcase, runs in white-metalled bushes and is driven by a two-row chain. It can be removed while the engine is in position on the chassis.

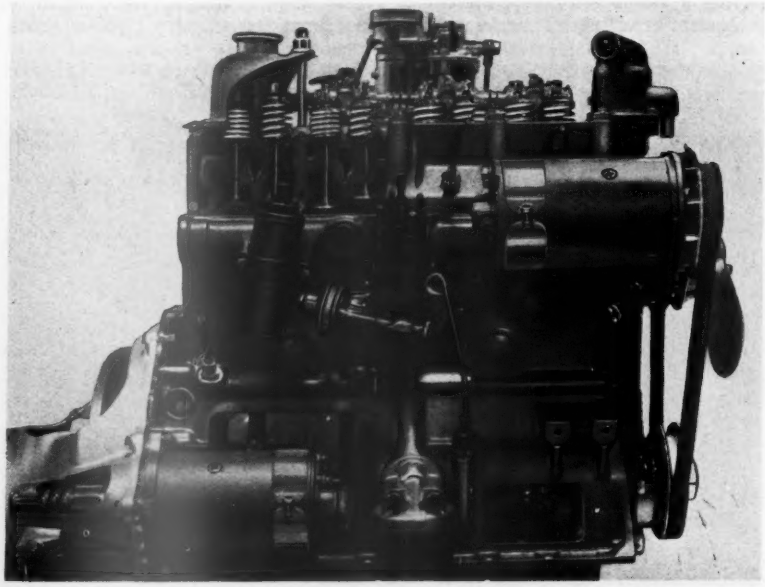
The connecting-rod big ends are split horizontally, the caps being secured by bolts, nuts and lock nuts. Flat-topped, solid-skirt, light-alloy pistons are steel-strutted and have their gudgeon pins offset $\frac{1}{16}$ in to the right-hand side. The cylinder bores have this same amount of offset from the centre line of the crankshaft. Two compression rings and one scraper ring are fitted above the gudgeon. The compression rings have swept upper faces to provide a slight scraper action.

The combustion chamber is of wedge form, the valves being inclined to seat in line with the upper sloping portion of the wedge. Long reach, 14 mm sparking plugs are located at the base of the wedge. The valves are operated by push rods having conventional screw and lock-nut adjustment. The single valve springs have unequal coils to overcome any tendency to surge.

In each case the bore is 3·125 in and the stroke 3 in. This gives a swept capacity of 92 cu in (1,508 c.c.) for the Consul, and 138 cu in (2,263 c.c.) for the Zephyr. A compression ratio of 6·8 : 1 is common to both. The output of the Consul is 47 b.h.p. at 4,400 r.p.m. and 74 lb/ft torque at 2,000 r.p.m., while the Zephyr engine yields 68 b.h.p. at 4,000 r.p.m. and 122 lb/ft torque at 2,000 r.p.m.

The Zephyr engine may run up to a speed of 5,000 r.p.m. at maximum vehicle speed but, owing to the ultra-short stroke, the maximum piston speed is claimed not to exceed 2,500 ft/min.

An unusual feature of this engine



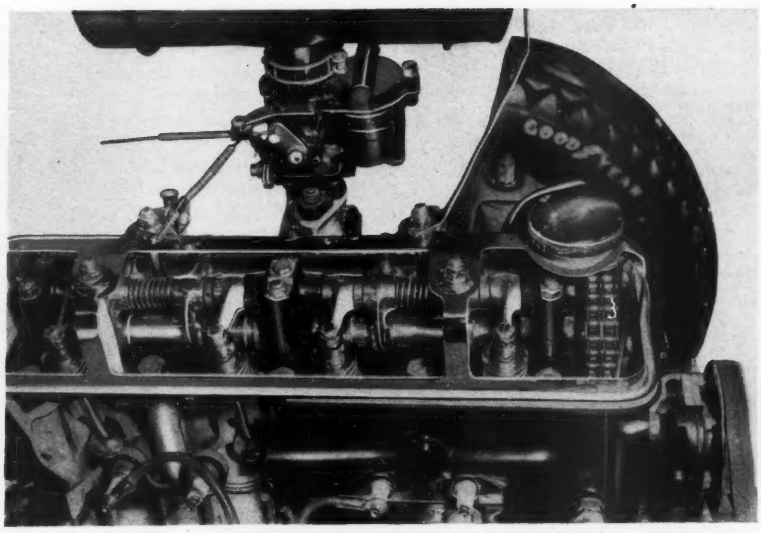
Right side of Austin A70 engine

is the cylinder head gasket, which is produced from a single sheet of bright steel and formed with a rib of semi-circular section close to the edge of each hole. The finished gasket is dipped in synthetic varnish. It is stated to be immaterial which face is uppermost when assembled.

Allard showed the J.2 competition model fitted with the Chrysler Firepower engine, a V-eight developing 180 b.h.p. This particular model is destined solely for export, but it is designed to accommodate alternatively the Ford V-8 3,622 c.c. engine fitted with the Ardun o.h.v. head conversion, or a Cadillac unit.

Among adherents to the overhead camshaft type of engine, the Jaguar is probably the most noteworthy, having regard to the way it has consistently sustained British prestige in the realm of speed coupled with reliability. The XK 120 engine is a six-cylinder of 83 mm bore and 106 mm stroke, the swept volume being 3,442 c.c. It has a maximum output of 160 b.h.p. at 5,200 r.p.m. and 195 lb/ft torque at 2,500 r.p.m. Alternative compression ratios of 7 : 1 or 8 : 1 are available, the latter for use with "Premium" quality fuels. The monobloc cylinder and crankcase is cast in chrome iron and only extends downwards to the crankshaft centre line. The seven main bearing housings are extensively ribbed and the casting, in addition to the normal water-jacketing arrangements, has a gallery in the upper portion of the left-hand side of the cylinder block. Into this gallery water is delivered directly from the pump.

The forged steel crankshaft, which has generous journal and crankpin diameters, is carried in seven thin-wall bearings. The stamped connecting rods are drilled to provide positive lubrication of the gudgeon pins carrying the domed-head, solid-skirt, tin-plated pistons. Two compression rings and one slotted scraper ring are fitted above the gudgeon. The upper compression ring is chromium-plated.



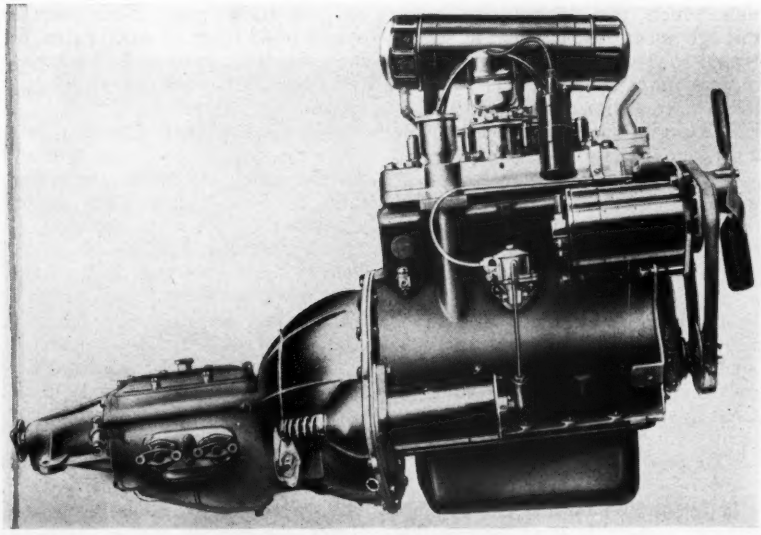
Overhead camshaft of Singer 1500 unit

The detachable cylinder head is in aluminium alloy and has hemispherical combustion chambers, the valves being on opposite sides of the centre line and arranged at an included angle of approximately 70 deg. Inlet and exhaust ports are thus almost completely uninterrupted and give the freest possible gas flow. There is a camshaft over each line of valves, the cams operating directly on inverted cup-type tappets which seat on the upper extremities of the valve stems. Lubrication is by a gear-type oil pump driven by skew gear from the front end of the crankshaft. Oil is drawn from the extremely large die cast sump by a floating inlet pipe.

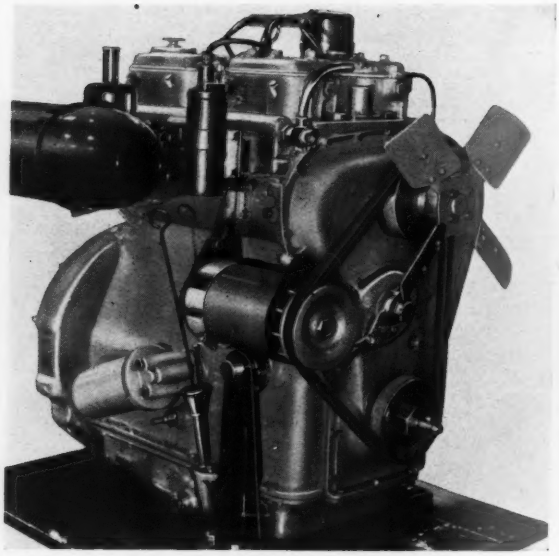
Singer continue the SM1500 chassis with but minor modifications. The four-cylinder engine has overhead valves operated by a single overhead camshaft. While the bore remains at 73 mm the stroke has been slightly shortened, with the result that the capacity is now 1,497 c.c. as against 1,506 c.c. The monobloc cylinder casting has crankcase walls extending below the crankshaft centre line. The skirt of each cylinder barrel projects below the water jacket and is slotted on the left-hand side. This allows the connecting rod to be raised high enough after removal of the bearing cap for removal of the gudgeon from above the cylinder face. The flat-top aluminium alloy pistons have oval skirts and are tin-plated. Two compression rings and a scraper ring are carried above the gudgeon pin. As mentioned earlier, the crankshaft is a Meehanite casting.

An interesting feature of the nickel-chromium iron detachable head is the incorporation of the gas inlet passage. The water pump, mounted on the front of the cylinder block, delivers coolant to the cylinder head where a $\frac{3}{4}$ in diameter brass tube, drilled with jet holes effects directional distribution.

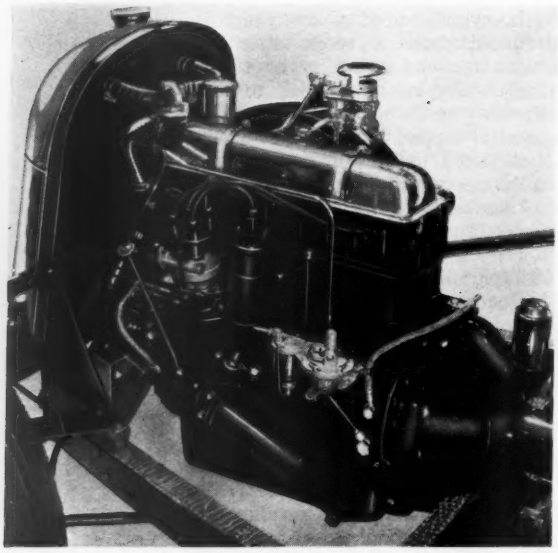
The steel camshaft runs directly in bearings formed in the cylinder head. The caps to these bearings form the rocker shaft supports and are located by tubular dowels round the studs. The rocker shaft is hollow and carries the L-shaped rockers on Glacier strip bushes. The two-stage camshaft drive is by two-row chains from the front end of the crankshaft,



Right side of Triumph Mayflower engine



Lea-Francis 2½-litre engine



Modified Vanguard engine in Morgan chassis

a spring-loaded jockey wheel being fitted at the front of the head.

The engine is mounted on widely spaced bearers at the front and by a single bearer under the back of the gearbox. Rubber mouldings are interposed to permit a reasonable amount of float. Developing 48 b.h.p. at 4,500 r.p.m., this unit is also fitted to the Singer Roadster in place of the "Nine" engine for export markets only.

Powering the Bristol 401 saloon, the type 85C six-cylinder engine is distinguished by a number of unconventional features. Having a bore and stroke of 66 mm and 96 mm respectively, the swept volume is 1,971 c.c. Fitted with three Solex carburettors, it develops 85 b.h.p. at 4,500 r.p.m. and maximum torque output 106·8 lb-ft at 3,500 r.p.m. The cylinder block and crankcase are a single iron casting, and it is notable that the water passages do not extend the full length of the paired cylinder bores. The skirt of the crankcase is carried down only to the crankshaft centre line.

The forged steel crankshaft has integral balance weights, machined on the side faces. As the crankpins are bored, the oilways are formed by inserted tubes. The stamped steel connecting rod big-ends are split horizontally and the caps are located and secured by shouldered studs. Big-end bearings are Vandervell, steel-backed, lead-indium type. Pressed in aluminium alloy, the solid skirt pistons are machined elliptically and also tapered. After completion they are tin-plated. They carry three compression rings and one slotted scraper ring, the third compression ring having a slight taper on the working face. Piston crowns are slightly domed.

The cylinder head is cast in R.R.50 and has inserts for the valve seats and sparking plug bosses. The two valves per cylinder are arranged at an angle of 80 deg and are operated in a rather unusual manner. Low down in the left-hand side of the crankcase a steel camshaft is carried in four bearings of progressively smaller diameter from the front. It is driven by a two-row roller chain from the crankshaft in a single stage, with no adjustment.

Over each bank of valves is a rocker shaft. The inlet rockers are operated directly by hollow push rods seating in reversed-piston type tappets. On the same rocker shaft intermediate bell-crank rockers are mounted. They are operated in the same manner by push rods and engage the ends of transfer rods which pass across the head, through tubes inserted in the rocker boxes, to operate the exhaust valve rockers on the other shaft.

The combustion chambers are semi-circular in a longitudinal section but are approximately V-shape in cross section with the spark plug located at the apex. Inlet passages are formed in the head casting in inverted Y-form.

Lubrication is effected by a gear type pump whith delivers lubricant to a full-flow filter mounted on a machined face on the left side of the crankcase. From the filter the oil is passed to the main gallery drilling which runs the full length of the engine on the left-hand side. An adjustable relief valve limits the pressure to 60 lb/sq in at 3,000 r.p.m.

Cooling water is circulated by a pump mounted on the front of the cylinder head. It is of interest that the coolant is delivered directly into the front of the cylinder head water-ways on the exhaust side, with no special arrangement in the form of directional jets. There is no forced circulation around the cylinder bores. Temperature control is assured by means of thermostatically controlled radiator shutters.

Normally the Healey is powered by the 2½-litre Riley engine but, with a view to offering enhanced performance in dollar markets, it appeared last year in alternative form with a Nash engine. To meet the demand for a more powerful engine for use in this country it is now fitted, again alternatively, with a modified 3-litre Alvis engine. It is a six-cylinder o.h.v. engine of 84 mm. bore and 90 m.m. stroke, having a compression ratio of 7 : 1. This modified model is claimed to deliver 100 b.h.p. at 4,200 r.p.m. Alvis quote an output of 83 b.h.p. at 4,000 r.p.m. for their standard engine and 95 b.h.p. at the same crankshaft speed for the special sports model.

Aston Martin and Lagonda fit a 2,580 c.c. engine of 78 mm bore and 90 mm stroke. Using a compression ratio of 6·5 : 1, this o.h.v. engine develops 105 b.h.p. at 5,000 r.p.m. An alternative engine known as the Vantage, may be fitted in the Aston Martin. It has a compression ratio of 8·16 : 1 and produces 123 b.h.p. at 5,000 r.p.m.

In an unostentatious way, considerable changes have been made to the engine of the 4½-litre Bentley. Its six-cylinder engine now has the bore increased by 3 mm to 92 mm while the stroke remains unaltered at 114·3 mm. With Rolls-Royce and Rover, the Bentley engine shares the distinction of having overhead inlet

and side exhaust valves. Again, as with Rolls-Royce, performance figures are not quoted for the 4,566 c.c. engine, but it is known to be capable of propelling the standard model saloon, weighing 4,088 lb unladen, at a timed mean speed of 100 m.p.h. Some part of this improvement at least is probably due to the introduction of a twin exhaust system which increases the output of the engine by relieving it of a certain amount of back pressure. Significantly, it is on record that the 4,257 c.c. Rolls-Royce engine developed 122 b.h.p. when fully silenced in the chassis against 137 b.h.p. with open exhausts on the test bed.

Basically, the Bentley and Rolls-Royce engines are alike, having a monobloc cylinder casting in which the cylinder barrels are well spaced owing to the use of a seven-bearing crankshaft. As part of the maker's aim to produce an engine that will have a working life of 100,000 miles before reboring is necessitated, the upper part of the cylinder bores in the path of the compression rings are chromium plated.

The forged, counter-weighted crankshaft is machined all over and is unusual in that the crankpins are drilled and closed with plugs of such form that any solid matter in the lubricant is thrown by centrifugal force into the recesses. Stamped steel connecting rods are also machined all over and are drilled for the positive lubrication of the floating gudgeon pins. All bearings are of Vandervell strip type with indium-faced lead-bronze linings.

Aluminium alloy pistons have split skirts and carry two compression rings and one oil-control ring. The detachable aluminium cylinder head has screwed-in seat inserts for the overhead inlet valves. Since there is only one valve per cylinder in the head, it becomes possible to fit an unusually large valve, also to provide generously proportioned induction and water passages.

Both sets of valves are operated from a camshaft mounted on the left-hand side of the cylinder block. The camshaft is fitted with a fabric-reinforced, helical-toothed gear meshing with a steel gear wheel on the crankshaft. Chilled cast-iron piston type tappets, having relieved faces, bear on "backed-off" cams. The side-type exhaust valves are actuated directly while alternate tappets carry push rods to operate the hollow rockers for the inlet valves. They are hollow in order to carry oil from the rocker shaft, under pressure, to the upper ends of the push rods and inlet valve stems. To prevent excessive lubrication and possible loss of oil, the stems are fitted with conical felt washers compressed by the inner valve spring.

The lubrication system now includes an externally mounted full-flow filter. A submerged gear-type pump draws oil from the sump through a floating strainer. A two-stage relief valve permits pressures in the main system up to 40 lb/sq in and to 5 lb/sq in for the tappets and overhead valve gear. The oil filler is mounted on the rocker cover and has a snap type cap.

Cooling is by a centrifugal pump which forces the water through a flat tube running the full length of the cylinder block and having jet openings to direct it around the exhaust valve seats. Thence it passes to the head and is discharged past a thermostat to the top of the radiator. The cylinder barrels are cooled by thermo-siphonic action.

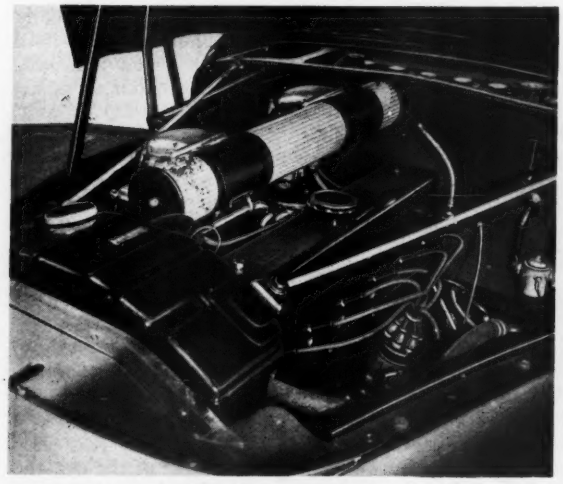
The engine not only has a torsional damper at the front end of the crankshaft, but the flywheel has a spring centre designed to damp out any oscillation at the rear end of the shaft.

Although having the same general valve arrangement as Bentley and Rolls-Royce, Rover position the side exhaust valves at a considerable angle. The 2,103 c.c. engine has a bore of 65·2 mm and stroke of 105 mm and, using a compression ratio of 7·25 : 1 develops 75 b.h.p. at a crankshaft speed of 4,200 r.p.m.

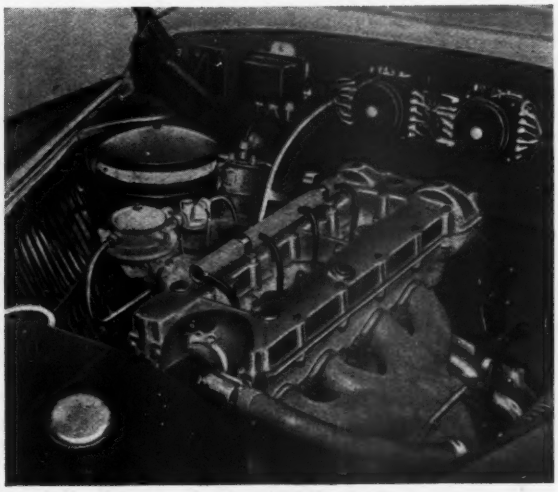
Seventeen American and Canadian cars were exhibited but they were all 1951 models. No 1952 models are expected to appear until December at the earliest. It is suggested that more V-eight engines will materialize. Among those that will not be announced before February will be an entirely new Ford.

Packard cars exhibited were fitted with the Thunderbolt 200 side-valve engine. It is an eight-cylinder in-line unit of 288 cu in (4,719 c.c.) displacement, bore and stroke being $3\frac{1}{2}$ in (88·9 mm) and $3\frac{3}{4}$ in (95·2 mm) respectively. The power developed is 135 b.h.p. at 3,600 r.p.m. by the standard engine having a compression ratio of 7 : 1. A high compression head, raising the ratio to 7·5 : 1 and giving an increase of only 3 b.h.p., is fitted on units to be used with Ultramatic drive.

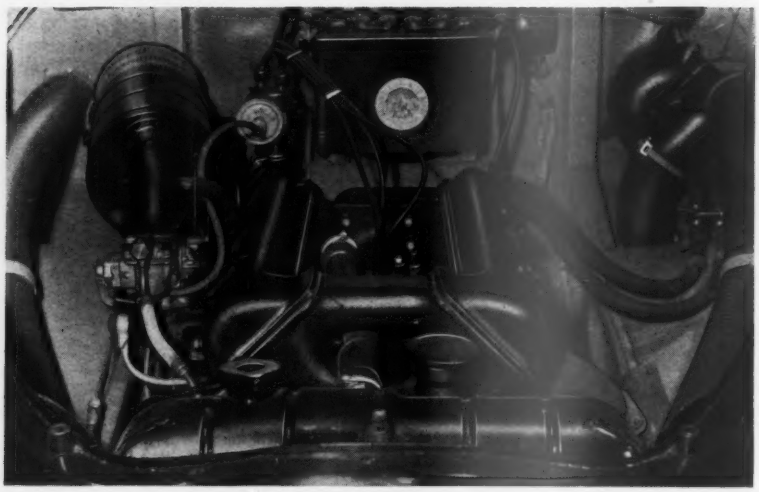
A vibration damper is fitted, its housing being welded to the back of the fan-belt pulley. It takes the form of a heavy metal ring which floats in a viscous fluid in a sealed container. The camshaft is mounted low down on the right-hand side of the semi-steel cylinder block and operates the valves through mushroom-headed tappets. Hydraulic lifters are interposed to eliminate tappet noise. The camshaft



Hotchkiss $3\frac{1}{2}$-litre engine



Salmson twin overhead camshaft engine



Alfa-Romeo 1900 engine

is driven by a short inverted-tooth chain.

Lubrication is by a gear-type pump delivering oil through galleries to the main bearings, and a floating screen filter is used. The oil filler tube is fitted with an air filter and is open to the blast from the fan. A trap is fitted to the breather pipe from the valve chest cover to retain oil. Pump cooling and a pressure-type radiator cap operating at 7 lb/sq in are used.

In their Saratoga saloon, Chrysler fit the new V-eight, 5·3 litre Firepower engine, which is claimed to be the most powerful American automobile unit. It develops 180 b.h.p. at 4,000 r.p.m.

The cylinders have a bore of $3\frac{13}{16}$ in (96·8 mm) and a stroke of $3\frac{7}{8}$ in (91·1 mm) and are arranged in two banks at 90°. Its compression ratio is 7·5 : 1, which would appear modest having regard to current American tendencies. The cylinder banks and the upper part of the crankcase are cast in one block, remarkable for the full depth of the water jackets. Combustion spaces in the detachable cylinder heads are fully hemispherical in form, the valves being disposed at an included angle of 60°. Spark plugs are mounted centrally, on the cylinder axis. Slipper-type pistons of aluminium alloy, with steel struts, carry two compression rings and one slotted, oil control ring ; all above the gudgeon pin.

A very heavy crankshaft incorporates six large counter-weights and is supported in five main bearings. The camshaft is mounted centrally above the crankcase and operates the push rods through hydraulic, self-adjusting tappets. Owing to the wide-angled position of the valves there are two rocker shafts to each cylinder head. Directional water circulation is effected by a centrifugal pump, a by-pass thermostat being fitted. The cooling system capacity is no less than 50 pints.

The engine is very flexibly mounted on the so-called "Floating Power" system.

The fairly large French contingent was the more interesting for the fact that it was well assorted. In all, ten manufacturers were represented.

Renault continue the successful 750 model which has a vertical four-cylinder engine of 54·5 mm bore and 80 mm stroke. It has overhead valves and a compression ratio of 7·25 : 1. Its rated output is 21 b.h.p. at 4,000 r.p.m. This engine is mounted at the extreme rear of the chassis, in unit with the gearbox and final drive.

Panhard now produce the interesting air-cooled, flat-twin, Dyna model in no fewer than four types. The smallest is the 610 c.c. type 110, having a bore and stroke of 72 × 75 mm and an output of 28 b.h.p. at 5,000 r.p.m. The compression ratio is 7 : 1. Next, there are two 79·5 mm bore × 75 mm stroke 745 c.c. models. Type 120 develops 32 b.h.p. at 5,000 r.p.m., and type 120 (Sprint) 38 b.h.p. at the same engine speed. Lastly, there is the type 130 of 85 mm bore × 75 mm stroke, producing 40 b.h.p. at 5,000 r.p.m.

These engines have the separate cylinders cast in light alloy, with non-detachable heads, cast steel liners and renewable steel valve seats being fitted. Probably the most unusual feature of the engine is the method of valve actuation. The rockers are operated by push rods from cams in the usual manner but, instead of helical springs, torsion rods are employed to close the valves. The end of valve stem is shaped with an enlarged area in which is a recess engaged by one end of a claw-shaped lever. The other end of the lever is pivotally mounted and receives the serrated free end of the torsion rod. The two torsion rods are arranged closely parallel and are otherwise unsupported but are united at extremities to furnish a mutual anchorage. The engine is also unusual in that the crankshaft is mounted on roller bearings.

The type 203 Peugeot is fitted with a four-cylinder, 1,290 c.c. engine of 75 mm bore × 73 mm stroke and developing 42 b.h.p. at an unspecified crankshaft speed. The wide monobloc cylinder casting is fitted with detachable, wet-type cylinder liners. Overhead valves are operated by push rods from a camshaft driven by a two-row chain, and are disposed to permit a combustion chamber of approximately hemispherical shape.

An interesting feature of the design is that the spark plugs are mounted vertically and are therefore completely encased. They are protected from oil by long tubes of a non-conducting material carried in caps which engage in position on top of the rocker cover by means of bayonet catches. The ignition leads are carried to these caps.

In its new guise, the Salmson is powered by an interesting four-cylinder 2·2-litre engine of 82 mm × 105 mm bore and stroke. This is largely built from light alloys, even to the stamped connecting rods which run directly on the crankpins. The nitrided crankshaft runs in three bearings and from its rear end drives the twin overhead camshafts through a train of gears.

Combustion chambers are hemispherical and the spark plugs are located centrally in an upright position. Power developed is 71 b.h.p. at 4,000 r.p.m.

The Simca "Aronde" is a new departure as its makers, who formerly built Fiat cars under licence, have decided to produce a new and individual French car. Its o.h.v. engine, based largely on the Fiat "1100" unit, has four cylinders of 72 mm bore and 75 mm stroke. The swept capacity is 1,221 c.c. and, with a compression ratio of 6·7 : 1, it develops 45 b.h.p. at 4,400 r.p.m.

The sole exhibit from the rapidly growing post-war German motor industry is the Porsche which is powered by an air-cooled, flat-four engine of 1,286 c.c. swept volume. Basically, the design is that of the Volkswagen, first shown in Berlin in 1939. The engine is mounted as a unit with the gearbox and axle differential at the rear of the car, the engine being behind the axle.

The aluminium alloy crankcase is

built in halves that meet on a vertical plane on the crankshaft axis. It incorporates a wide but rather shallow sump, finned on the underside. The four cast iron cylinders are separate and interchangeable. Cylinder heads are cast in pairs from aluminium-silicon alloy and the assembly on each side is secured to the crankcase by eight long bolts. The cylinders on the two sides are staggered to suit the four-throw crankshaft, which is a steel forging carried in three main bearings. An additional outrigger bearing forms a steady for the somewhat heavy auxiliary drives. The main bearings are of lead-bronze in steel shells which, with the exception of the centre one, are continuous in form.

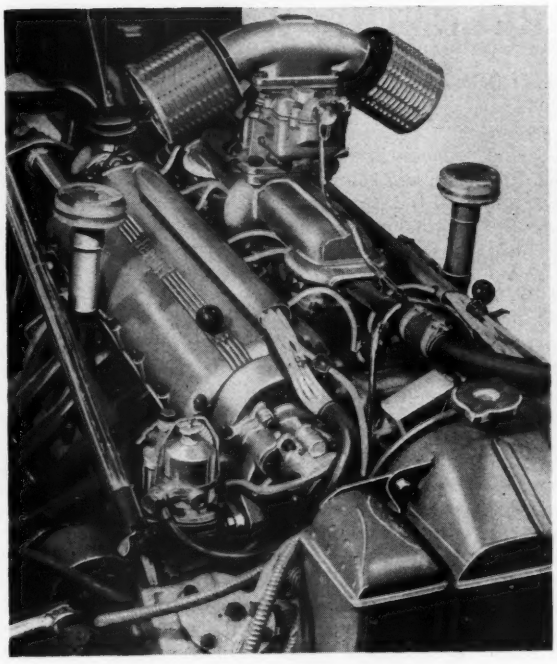
Steel connecting rods of H-section are directly metalled in the big-ends.

The die-cast light alloy pistons, with domed heads and thin skirts, carry two compression rings and one scraper ring above the gudgeon.

The cast iron camshaft runs in three bearings below the crankshaft and is gear driven. Operation of the overhead valves is by push rods of unusual construction. They are tubular and the inner ends have an enlarged diameter so that they also serve as the tappets, the actual tappet ends and the spherical outer ends being hardened steel components. The valves work in phosphor-bronze guides and seat on bronze inserts. Steel bushings are fitted to take the sparking plugs.

A recent modification in design is the adoption of a substantially hemispherical combustion space. This has necessitated a change in the angular position of the outer valve of each cylinder.

Probably the outstanding feature is the cooling system. Being mounted and enclosed at the rear of the vehicle, the engine is cooled by a system of induced air circulation. To effect this a sheet metal cowling is fitted above and over most of the engine and incorporates the housing for a blower. High above the front of the engine, the dynamo is carried in a cradle formed by an extension of the crankcase casting and driven by a heavy V-belt from the crankshaft. The armature shaft is extended rearwards and carries a vaned, aluminium alloy, fan rotor. The cowling enshrouds the rotor and air is drawn in through a 6 in diameter intake facing rearwards.



Ferrari 12-cylinder type 212 engine

Cylinder dimensions are : bore 80 mm and stroke 64 mm. Utilizing a compression ratio of 7 : 1, the maximum power output is 44 b.h.p. at 4,000 r.p.m.

The complete power and drive unit is carried on rubber mountings so disposed as to permit a measure of rocking movement about its centre of mass. There are two mountings at the rear of the unit and the front one is a rubber annulus.

Apart from their successes in speed events the Ferrari is worthy of careful study for the carefully balanced character of the design as a whole. Two examples were shown. Model 212 Export has a twelve-cylinder, 60° V-type engine of 68 mm bore and 58·8 mm stroke which gives a swept volume of 2,562·51 c.c. Compression ratio is 8 to 1 and it develops 150 b.h.p. at 6,500 r.p.m. The 342 America model has an engine of the same bore, but the stroke is increased to 80 mm, making the swept capacity just over four litres. For this unit an output of 200 b.h.p. at 4,800 r.p.m. is claimed.

The engine, remarkably compact for its power output, has the two banks of cylinders and the upper half of the crankcase cast in one. At the rear end the casting incorporates the forward upper portion of the clutch housing and is extended outwards on either side to form the rear engine bearers. There is also a bearer arm on each side, level with No. 2 cylinder on each block.

Seven bearings carry the robust, forged crankshaft, two connecting rods bearing on each crank pin. Connecting rods of H section have extremely large big-ends which are split at an acute angle. The caps are secured by setbolts with locking strips between them. Pistons have domed tops and carry four rings, three being above the gudgeon. An unusual feature is the drilling of oil holes from the ring groove immediately above the gudgeon to the gudgeon pin hole.

Cylinder heads for each bank of cylinders are detachable. The hemispherical combustion chambers accommodate two valves per cylinder which are operated directly by rockers from an overhead camshaft. The two camshafts are chain driven from the front of the crankshaft. At the front of each camshaft is a direct extension drive for the Marelli six-cylinder magneto, though a distributor with attached coil may be fitted alternatively.

Lubrication is effected by a gear pump mounted horizontally in the front of the sump and driven from a gear wheel on the crankshaft between the forward main bearing and the chain wheel for the camshaft drive. A large, removable element filter is fitted at the front of the engine and the lubricant is cooled by a vertical oil radiator fitted to the right-hand side of the main coolant radiator. In cross section, the cast aluminium sump takes the form of an inverted "T", being widely extended on each side. It is longitudinally finned on the base and the lateral wings.

Each valve chest is vented to the induction manifold. A diaphragm-type fuel pump, also at the front end, is driven from the magneto drive shaft. The dynamo is cradle-mounted between the two distributors and is positively driven.

Water circulation is effected by a large centrifugal pump mounted to the left-hand side of the front of the engine and driven by a jockey shaft bearing at its rear end a three-row chain wheel engaging the back of the left-hand camshaft chain. The engine is carried in the chassis frame by four resilient mountings.

Alfa-Romeo showed the 1900 model engine, a 1,884 c.c. unit having a bore of 82·55 mm and stroke of 88 mm. Compression ratio is 7·5 : 1 and the rated maximum output is 80 b.h.p. at 4,000 r.p.m. Valves are arranged at a wide angle in the head and operated, through inverted tappets, by twin overhead camshafts.

CARBURATION AND INDUCTION

More Attention to Cold-starting and Fuel Filtration

DESPITE the prophets who during the war foretold the early demise of the carburettor in favour of petrol injection, the carburettor continues to hold the field against all comers. All American and Continental engines exhibited were equipped with carburettors of the open-choke variety. In this country, however, both the open-choke and the constant-vacuum type are in widespread use, and British cars exhibited were fitted with either of these versions. The S.U. Company continues as the exponent of the constant-vacuum carburettor while Solex, Zenith, and Zenith-Stromberg represent the open-choke form of instrument. The Weber, a relatively recent newcomer to the European field, is produced in Italy and forms part of the carburation equipment of some Continental cars.

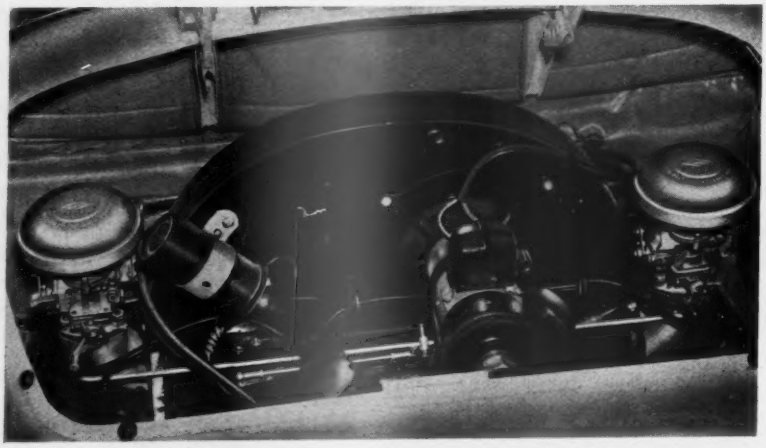
Although the gradual lowering of the bonnet-line tends to put the downdraught carburettor at a disadvantage, owing to the small clearance between the air silencer and the underside of the bonnet, the popularity of the downdraught carburettor is unquestioned. There has been much talk in recent years about America going over to the horizontal carburettor but there is, as yet, no sign of this. Carburation on American cars remains one hundred per cent downdraught. In this country, however, the horizontal carburettor, although not as widely used as the downdraught, has a large following.

All modern carburettors provide means of enriching the mixture for cold starting. Solex carburettors incorporate a small auxiliary starting carburettor, controlled by means of a cable from a knob on the facia. Zenith and Zenith-Stromberg on the other hand employ the off-set mounted strangler valve with linked fast-idle control on the throttle valve. With this arrangement the closing of the strangler valve, again by a facia-controlled knob, automatically opens the throttle valve a predetermined amount, so ensuring that the engine will fire and continue running when cold. All the American cars shown bear this form of starting equipment, but in most cases the control, instead of being by hand, is entirely automatic, being controlled by a thermostatic element. This arrangement is known as the "automatic choke." Various forms of automatic starting are widely favoured in America, and with the exception of the Chevrolet and the Kaiser "Henry J" model, all the American cars exhibited were so equipped.

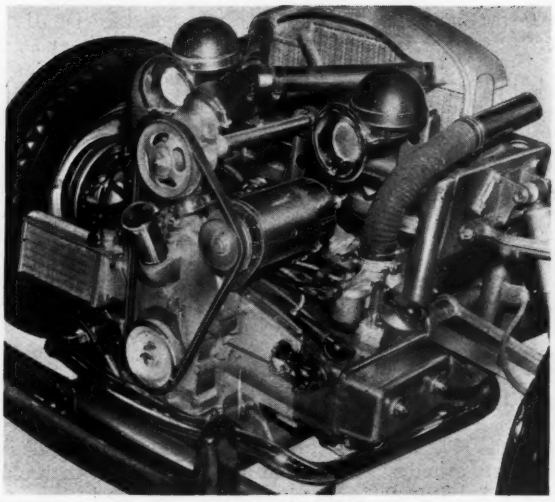
In brief, the system comprises a strangler valve mounted on a spindle which is slightly off the centre line of the main air passage through the carburettor. Thus, when the strangler valve is closed, the airflow against the larger off-set portion of the valve tends to force it open. Linked to the strangler spindle is a bi-metal thermostat spring of the flat coiled type, similar to a clock spring, and the assembly is so arranged that the spring when cold, holds the strangler valve in the closed or starting position. Heat is imposed upon the thermostat spring either by locating it in a recess in the exhaust manifold or water-heated hot spot, or by passing exhaust-heated air over the spring. Thus, as the engine warms up, the spring gradually loses tension and releases the closing constraint on the strangler valve in proportion to the increasing warm-up of the engine. Almost invariably, an automatic fast-idle system is incorporated in the assembly to ensure freedom from stalling during the warm-up period. This is done by linking the throttle valve with the strangler system in such a manner that the throttle is opened slightly during cold starting and warming-up. All the exhibited American cars equipped with automatic chokes use exhaust heat to warm the thermostat spring, as do the majority of British cars shown with this system. An exception was that of the Rolls-Royce Silver Wraith, where the thermostat is located in a recess in the water-heated hot spot of the induction manifold.

On the S.U. constant-vacuum carburettor, cold starting is effected by lowering the jet sleeve which surrounds the jet needle. On most models exhibited this is operated manually by a control from the facia but in some cases, among which were Jaguar, Wolseley and Aston-Martin models, an auxiliary automatic cold-starting system is incorporated. In effect, this is a small separate carburettor which supplies a rich cold-starting mixture directly into the induction tract, completely by-passing the main carburettor. It consists of a solenoid-operated needle valve; the solenoid of which is put in and out of action by an electric switch controlled by a thermostat spring located in the coolant system.

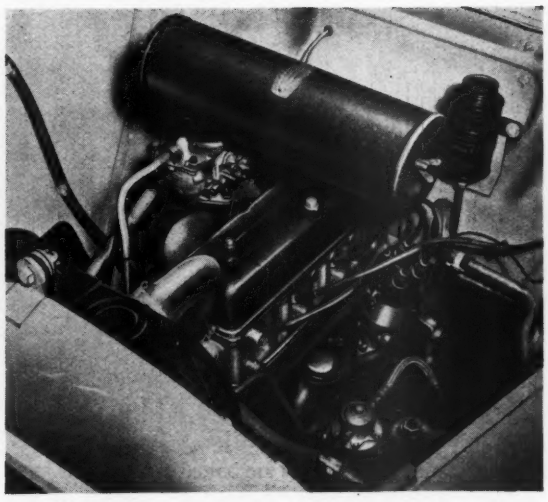
Probably the most notable innovation in carburation at this Show was the water heating of the throttle body on some new American cars, as a prevention against throttle icing when cold or cool. The new Chrysler Firepower engine was an example. Icing is liable to occur under certain conditions of temperature and humidity on the East coast of America, during the warm-up period. It is aggravated by increased fuel volatility, and the slower warm-up speed associated with cars equipped with an automatic transmission doubtless makes matters worse. It is a condition from which we in this country appear to suffer little although, of course, icing in aircraft carburettors has long been recognized as a dangerous source of trouble. In the case of the Chrysler Firepower, the throttle body of the carburettor is cored



Twin carburettors and siamesed risers on the Porsche



Carburation system on the Jowett Jupiter



Simca integral induction and exhaust manifolds

with passages through which is fed coolant liquid from the cylinder head, so that the throttle body warms up rapidly. However, in view of prevailing difficulties caused by vapour troubles in hot weather, such as difficult starting when hot and kindred complaints, any additional heating of the carburettor would appear to aggravate matters. The aim of carburation specialists in this country is to heat the mixture after metering, but to keep the fuel pump, fuel line and carburettor cool. It seems possible, however, that with any considerable increase in the volatility of our fuel we also might encounter trouble.

Fuel supply from tank to carburettor continues to be by a pump, either of the mechanical type actuated from the camshaft and usually of the A.C. pattern, or the electrically-operated type, produced by the S.U. concern. This has commonly a single pumping element, but a component pump with twin pumping elements is also produced. Among the manufacturers who fit this are Rolls-Royce, Bentley and Aston-Martin. Fuel pumps on American cars exhibited were exclusively of the mechanical type. In most cases care is taken to locate the fuel pump in a relatively cool spot, remote from exhaust heat, but several instances were observed where the fuel pump is much too close to the exhaust system. Many of the fuel pumps on the American exhibits are composite assemblies, with twin diaphragm systems working from a single push rod. One pumping element serves to propel the fuel from the tank to the carburettor, while the other is in circuit with the suction-operated windscreen wiper, and thus boosts the suction system, when the engine is pulling slowly on wide-open throttle.

Almost every car exhibited was fitted with an air silencer, or combined air silencer and filter. In some instances the silencer and filter elements are contained in a single vessel while in others the elements are separate; a silencer being fitted to the carburettor with a filter unit in series with it on the air entry side. Examples of separate silencer and filter systems were fitted to most of the larger cars produced for export.

Fuel filtration appears to be receiving rather more attention than previously. This is most commendable. All fuel pumps are fitted with a filter element on the suction side of the pump, and usually there is a small thimble gauze filter on the banjo bolt of the carburettor union. Actually, this is of little practical value as a filter and several car manufacturers are fitting an additional glass-bowl filter on the delivery side of the pump between the fuel pump and the carburettor. In one or two cases, however, the filter unit seems to be mounted in a position above the hot spot where it can pick up unwanted heat; a most undesirable factor in hot weather when vapour troubles may occur.

The air silencer, by reason of the restriction it imposes upon the entering air, has a marked influence on carburation and, of course, the carburettor has to be adjusted to deal with this restriction. The degree of air-entry silence now demanded is extremely high and the air silencing of large four-cylinder engines is no easy matter. In many instances the depression in the air silencer is employed to prevent crankcase breather fumes entering the car by venting the valve cover into the air-entry side of the air silencer. This is now largely common practice, although in some instances, notably that of the Standard Vanguard, a special A.C. crankcase-breathing system is incorporated. Broadly, air silencers are either of the end-feed type, where one end of the silencer is attached to the carburettor or the so-called T-type, on which the boss for attachment to the carburettor is in the middle of the outer silencer casing. The combined air silencer and cleaner, usually of the oil-bath kind, may be attached directly to the carburettor intake, or fixed to the engine or chassis and connected to the carburettor by a length of corrugated rubber hose.

In any installation of air silencer or cleaner, it is of the utmost importance that the silencer unit is adequately supported to relieve the carburettor of all stress. While most exhibits appeared to be well provided for in this respect, a few could have been given better support. Large-scale production of intricate die-castings for carburettors is only possible with zinc-base metal, which by itself is unable to sustain the high stresses imposed by engine vibration upon insecurely supported air silencers. Most American cars are now fitted with air silencers and cleaners having a quick-release clamp around the carburettor. This is usually a screw-controlled clamp with a long handle extending beyond the silencer casing. It is easily rotated by the fingers to release the clamp, and thus renders removal of the silencer a much easier matter than the familiar one of searching under the air silencer for a screwdriver slot or a nut.

Based on the design of the Volkswagen, the Porsche opposed flat-four engine is fed with mixture by two single downdraught Solex carburettors. This is an o.h.v. engine and an inverted Y-piece casting forms the induction passage for each pair of

cylinders. The carburettor is attached to the vertical portion and the two arms branch down and inwards to the cylinder inlet ports. A flat, circular air silencer is fitted to each carburettor and a long throttle control rod runs across the engine linking the two throttle valves. Fuel supply is by mechanical pump and a glass-bowl type petrol filter is provided between the pump and the carburettors.

The new Austin Seven engine follows closely upon the design of the A.40. Mounted on the left-hand side of the o.h.v. engine, the two-port induction manifold is placed above that of the exhaust. A thin-plate hot spot of the Austin pattern is fitted between the induction and exhaust casting, where they are bolted together beneath the riser. As on the A.40 a metal deflector is attached to the underside of the hot-spot plate and is thus in line with the exhaust gases issuing from the centre exhaust port. Unlike the deflectors of the A.70 and the Sheerline, however, which take the form of a triangular casting bolted to the hot-spot plate, that of the Seven is a steel pressing, welded to the plate. The induction gallery is of round section, the turn of the gallery into the port branches being in a gentle curve. A small, downdraught Zenith carburettor is employed, to the top of which is attached an A.C. air silencer of the T-type. Following Austin practice, fuel supply is by a mechanical pump which is placed on the left-hand front of the engine.

A newcomer to the Renault range, the power unit of the "Frégate" is equipped with an induction system of the two-port type mounted on the right-hand side of the engine. Of cast aluminium, the induction manifold is above the exhaust and is of circular cross-section. The gallery curves round to form the port branches which fall quite sharply some 2 in to the ports. In accord with Renault practice, a thermostatically-controlled flap valve and hot spot is incorporated below the riser. The mixture is supplied by a Solex carburettor, and between this instrument and the manifold is a large, reinforced, asbestos heat-shield. A noticeable feature of this worthwhile item is its stiffness. Too often such shields are flimsy and quickly bend or droop. Placed across the engine and close up to the bulkhead is a long and slender cylindrical air silencer, of Tecalemit manufacture, connected to the carburettor intake by an elbow piece.

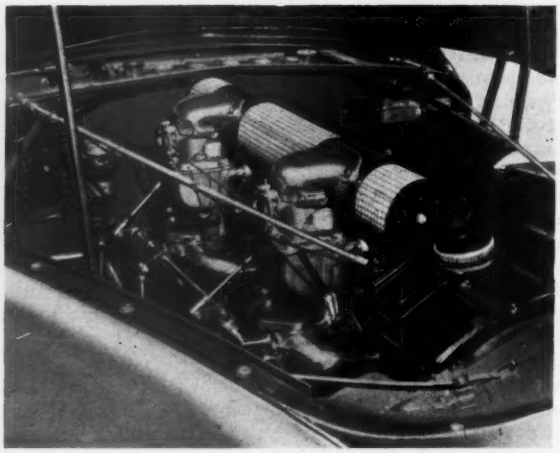
An excellent type of heat shield is fitted on the Citroen six-cylinder engine. In this instance a Solex dual downdraught carburettor is fitted, with the throttle spindle across the engine. The outer throttle barrel feeds the rear three cylinders and the inner barrel the front cylinders. The heat shield, placed between the carburettor and the induction manifold, is some 15 in long and 5 in wide. It consists of an aluminium sheet with an asbestos facing underneath, the whole being rigid and well supported.

Not previously exhibited in this country, the Simca-9 engine has cast iron integral induction and exhaust manifolds on the right-hand side. The only junction between the two is below the induction riser, and this forms the hot spot for heating the mixture. Of circular cross-section, the two-port induction gallery rises on each side of the carburettor and then falls inwards to the siamesed inlet ports. A drain tube is taken from the floor of the induction gallery just below the riser. Fuel supply is by a mechanical pump, arranged on the left-hand side and feeding the downdraught Solex carburettor. Mounted transversely to the engine is a Vokes type air silencer, the end of which fits directly to the intake of the carburettor.

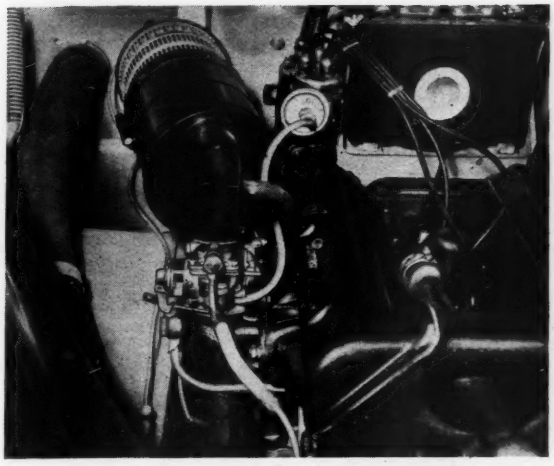
A rather unusual induction system is used on the Salmson 2·2 litre model. Lacking precise information of this layout, it is only possible to conjecture how the scheme is arranged. A Zenith U-type, horizontal carburettor is fitted with the float chamber to the rear, an unusual position on modern automobile engines. The carburettor feeds what appears to be an aluminium induction manifold of extremely small dimensions. No separate port branches are visible; the aluminium casting bolting direct to the cylinder head. As the engine is claimed to deliver 70 b.h.p. it would seem impossible to feed enough mixture through the small passage provided by this casting. It is possible that a part of the induction gallery is recessed in the cylinder head, and covered by the external aluminium casting, but this supposition could not be confirmed. A large air silencer, located vertically, is connected to the carburettor by a metal elbow. Cold starting is by a small auxiliary carburettor, operated by a disc valve placed above the throttle.

On the new Singer Sports engine an internal four-port gallery tract is employed. Similar to the SM-1500 engine, a single downdraught Solex carburettor is bolted to the flange of a riser tract cast integral with the centre branch of the three-port exhaust manifold. This passage curves down from the carburettor and inward to a horizontal tract leading into the centre of the induction gallery. The curvature and radius of this passage has been carefully designed to provide appropriate directional bias to the mixture passing inward to the gallery. Since the passage is directly above the

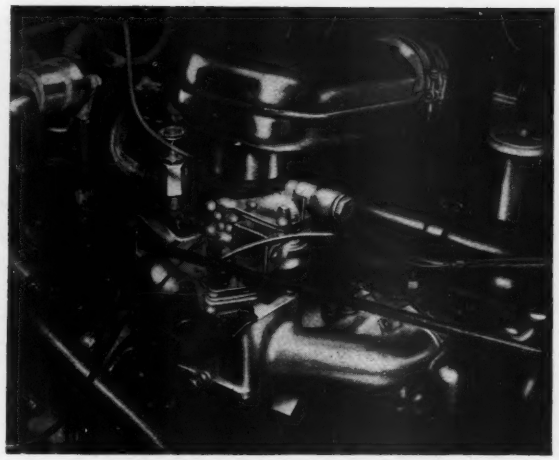
Horizontal carburettor on 2·2-litre Salmson



Hotchkiss heating arrangement of twin carburettors



Water-heated elbow riser on Alfa-Romeo.



Thermostatically controlled hot spot on Standard Vanguard

common exhaust branch of two cylinders, it is well heated and warm-up is rapid. From a manifold drain located at the bottom of the bend a pipe leads down clear of the engine. An A.C. air silencer of the T-type fits directly to the carburettor intake. With this type of induction the mixture in the main gallery is kept at an even, if high temperature.

The Wyvern, smaller of the two new Vauxhall cars, exhibited for the first time, is fitted with a four-cylinder engine very similar to that which powered the previous Wyvern model. Here the conventional two-port induction system feeding siamesed inlet ports is employed, but the arrangement is unusual among British cars by the inclusion of the American type of thermostatically-controlled hot spot. This feature, also appearing on the six-cylinder Velox, has been a standard item of equipment on Vauxhall cars for a number of years.

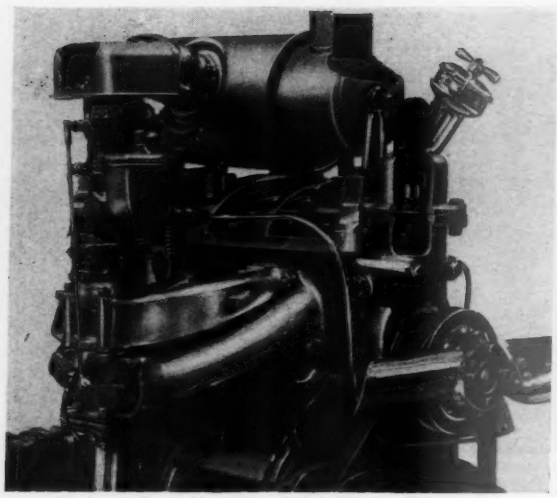
Mounted on the left side of the engine, the cast iron induction manifold is arranged above the four-port exhaust system. An exhaust-heated jacket surrounds the riser and gallery junction tee, and the flap valve of the thermostatic hot-spot device directs hot gases up and round the jacket when the engine is cold, and away down into the exhaust down pipe when hot. In common with other applications of the thermostatically controlled hot spot, the coiled thermostat spring is fitted to a projecting end of the flap valve spindle which is arranged, parallel with the crankshaft, below the induction manifold. Attached to the other end of the spindle is a weight which, when cold, rests against a pad fixed to a small bracket bolted to the induction manifold. In cross-section, the induction gallery is Ω-shaped over most of its length on either side of the riser, but merges into circular section as the cylinder-head ports are approached. From the riser tee, the galleries sweep down to the head ports. The mixture is supplied by a downdraught Zenith carburettor of the economizer type. Cold starting is by means of an off-set and spring-loaded strangler valve, together with automatic fast-idle. Mounted directly to the carburettor is an A.C. air silencer of the end-feed pattern.

Also of the two-port design with siamesed inlet ports is the Hillman Minx system, which is unchanged. In this case, however, the hot spot is obtained by the more familiar method of forming the induction and exhaust manifolds in a single casting, joined below the riser so that heat is transmitted direct through the metal to the mixture. Placed on the right side of the engine, the induction portion of the casing is above that of the exhaust, the induction tract being of rectangular cross section. The gallery curves round from riser to cylinder ports without any rise or fall. It is a straightforward design, with a small downdraught Solex carburettor fitted with an A.C. air silencer.

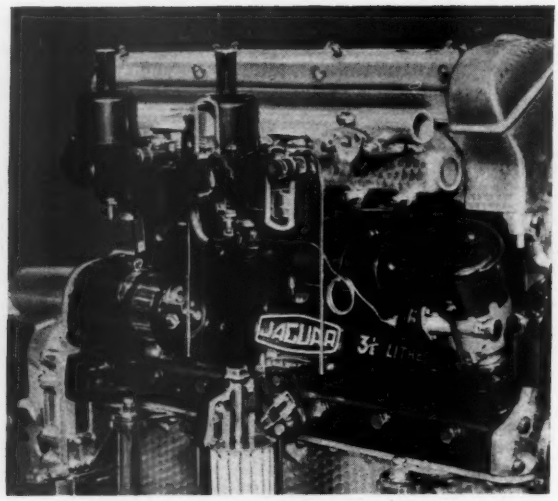
The Standard concern has made an important modification to the carburation system of the Vanguard. This consists of re-designing the induction and exhaust manifolds to incorporate a thermostatically controlled hot spot of the flap-valve type, as described earlier in connection to the Vauxhall engines. In general, the main features of the Vanguard induction manifold have been preserved. Arranged above the exhaust system, the induction manifold retains its combination of the two-port and four-port scheme. The induction galleries turn inwards towards the cylinder head, and then split into two, so presenting four branches to the inlet ports in the cylinder head. Following the common practice with this kind of hot spot control, the riser and gallery tee is jacketed and, when cold, the flap valve in the exhaust manifold below directs exhaust gases up and round the jacket. As is usual with the scheme, a counterweight is attached to the end of the spindle remote from the thermostat spring. A version of this engine forms the power unit of the Morgan "Plus Four" model, but on this the air silencer is omitted. Instead, a cowl plate is fitted over the air intake of the carburettor.

No change has been made in the carburation systems of the four-cylinder Morris Oxford and Wolseley Four-Fifty engines. Inlet and exhaust tracts are formed in a single casting, being joined in the usual way at the centre to provide the hot spot for heating the mixture. On each model a horizontal S.U. carburettor is employed to feed a gallery tract which curves round and down to the two siamesed inlet ports. On the Morris Oxford the horizontal, end-feed air silencer is joined to the carburettor intake by a fabricated connection piece of rectangular cross-section. A sheet-metal deflector between the carburettor and the exhaust manifold is, presumably, fitted to protect the carburettor from radiated heat.

The air-silencing equipment on the Wolseley Four-Fifty is somewhat different. Here a T-type silencer is mounted longitudinally above the manifolds and connected to the carburettor by a curved aluminium casting. The Morris Minor also has an integral manifold casting and is fitted with a horizontal S.U. carburettor. In this instance, however, the induction system is of the two-port



Sunbeam-Talbot 90, showing automatic choke



Jaguar XK120 water-heated induction system

straight-rake type, with buffer ends protruding beyond the junction of gallery and port branch. These branches fall sharply from gallery to cylinder port, the whole tract being of circular section. A hot spot is arranged around the riser and gallery tee, and a cylindrical, end-feed air silencer fits vertically on a fabricated connector piece attached to the carburettor. In common with all the Morris and Wolseley models, fuel supply to the carburettor is by means of an S.U. electric pump.

Introduced for the first time last year, the Lanchester Fourteen four-cylinder engine has the induction and exhaust manifolds on the right side of the engine. A downdraught Zenith carburettor supplies mixture to a four-port induction system of the straight-rake pattern; a design seldom encountered in these days. This follows logically upon the system employed on the Lanchester Ten, which had a four-port scheme of similar design. Of circular cross-section and cast in aluminium, the induction manifold is placed above the exhaust, to which it is bolted in the centre to provide the contact hot spot. Fuel supply is by A.C. pump and an end-feed air silencer is mounted across the engine; connection with the carburettor being made by a short length of hose.

Also exhibited for the first time at the previous Show, the Sunbeam-Talbot 90 with a four-cylinder engine having a twin-gallery induction of unusual design remains unchanged. This somewhat unorthodox scheme has proved very successful, and consists of a single downdraught Zenith-Stromberg carburettor feeding mixture into a twin gallery and thence to the four individual inlet ports in the cylinder head. Arranged above the four-port exhaust manifold on the right side of the engine, the induction manifold casting contains four separate tracts leading in sweeping curves from the riser to the head. The tracts lie side-by-side in plan, although they rise, perhaps, one inch from riser to cylinder port. Contact between induction and exhaust manifold is made below the riser, where a metal plate seals off a communicating aperture to form a thin-plate hot spot.

Incorporated in the downdraught carburettor, which is of the economizer type, is the Zenith-Stromberg automatic choke. A small recess located in the side of the exhaust manifold casting houses the bi-metal thermostat spring. Attached to the outer end of the spring spindle is a lever, linked to the strangler valve spindle by means of a light rod. The scheme embodies an automatic device for opening the strangler a specified amount when the engine first fires from cold to prevent the mixture from becoming over-rich, and also an automatic fast-idle to prevent stalling from cold. This arrangement is very similar to the automatic choke starting systems employed on nearly all the American cars exhibited.

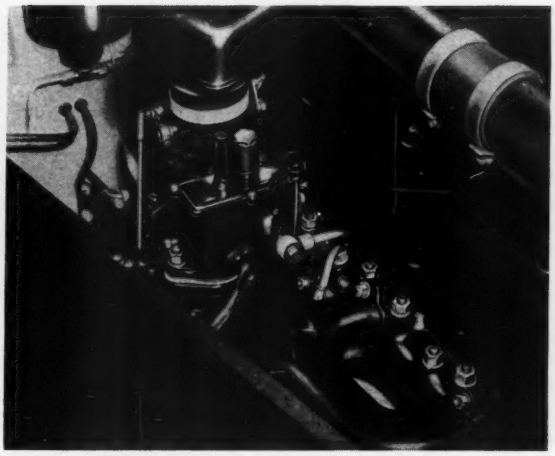
A compound air silencing and cleaning system is employed. An A.C. T-type air silencer is mounted over the rocker cover and connected to the carburettor by a metal elbow and a short length of rubber hose. Attached to the intake of the silencer is a corrugated rubber hose which leads to the oil-bath air cleaner placed on the right side of the engine. In order to obtain a cooler intake charge and thus reduce any tendency to detonation, the air intake of the cleaner is taken from the front of the car, through the vent on the side of the radiator. It is surprising that this scheme of taking the intake air from the front of the car is not more widely followed as its value is unquestioned. Admittedly, there is some possibility of icing within the critical band of temperature and humidity, but this could be overcome by fitting a simple flap valve for seasonal adjustment.

The popularity of the dual carburettor on six-cylinder engines has for some time been a somewhat variable quantity, and an interesting change has been made on the new Rolls-Royce Silver Wraith. On cars produced since the war, carburation has been by a dual downdraught Zenith-Stromberg unit, complete with automatic choke. On the new model the induction and carburation systems have been completely revised, with a single downdraught Zenith-Stromberg carburettor replacing the dual instrument of previous years. This has necessitated a redesign of the entire induction scheme, for with the dual carburettor scheme each throttle barrel of the carburettor fed three cylinders through a separate induction tract.

Although the new engine has a larger bore, $3\frac{5}{8}$ in instead of $3\frac{1}{2}$ in, the general arrangement of cylinder head and porting is almost identical with that of the smaller engine. As before, the combustion chambers are of the so-called F-type, with overhead inlet and side exhaust valves. The six-port exhaust manifold, arranged on the left side of the engine, comprises two separate castings each having three ports. A single downpipe leads to the silencer, the top of the pipe being bifurcated and flanged to the off-takes of the manifold.

As previously, the two outer inlet ports in the right-side of the cylinder

head are single ones, while intermediate ports are siamesed to provide four-port induction. Of aluminium and stove enamelled, the induction manifold has a gallery and port branches of approximately square cross-section. The two inner branches leave the gallery at right angles but the two outer port branches emerge in generous curves. Following Rolls-Royce practice, the branches fall slightly towards the cylinder head ports. To compensate for the 1½ deg inclination of the engine, the gallery of the induction tract is arranged with a 1½ deg tilt upward at the rear, so that the gallery remains parallel with the road. This results in there being a little more fall from the gallery to the rear port branches than to the front. Water heating for the hot spot is retained, a jacket being cast around the tee of the gallery and riser and extending on each side as far as the two inner port branches.



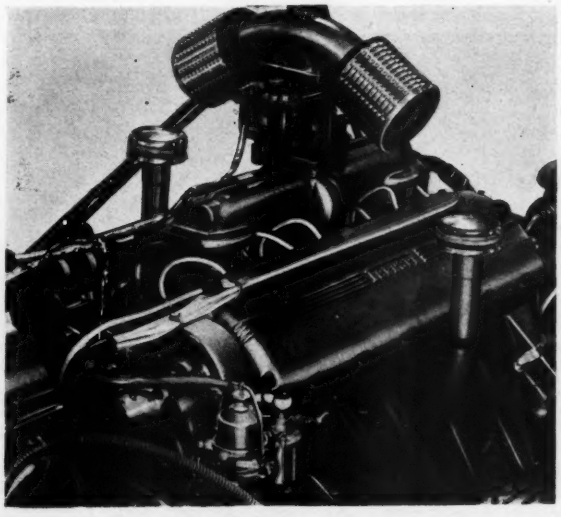
Revised carburation system on R-R Silver Wraith

Situated with the float chamber to the front, the single-barrel, down draught Zenith-Stromberg carburettor is of the economizer type, with a vacuum-operated valve ensuring lean mixtures at part throttle with the required enrichment for full throttle power. Incorporated also is the Zenith-Stromberg automatic choke, complete with off-set strangler valve, vacuum-operated strangler opening and automatic fast-idle. The carburettor thermostat unit is located in a recess in the coolant-heated hot spot. A large A.C. air silencer of the L-type, mounted across the engine and inclined slightly to the rear, is connected to the carburettor intake by a short length of rubber hose. Like the Bentley, the carburettor is fed by a twin-element S.U. fuel pump situated in a relatively low position on the chassis, and so away from the heat of the engine. A petrol filter of the detachable-bowl type is placed at the rear of the chassis near the fuel tank. It is thus on the suction side of the fuel pump and its fire hazard is low.

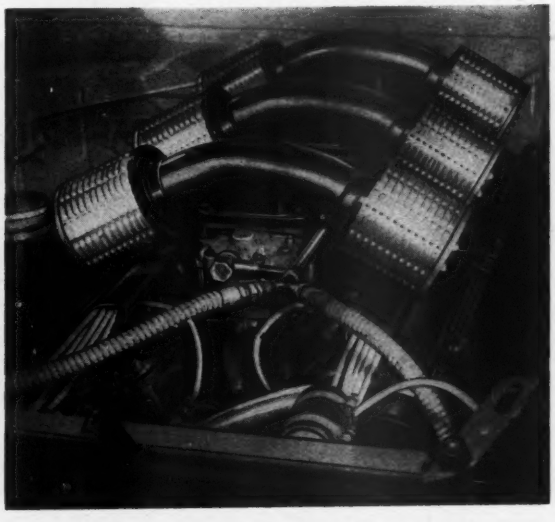
No alteration has been made to the carburation scheme of the Bentley, but with the introduction of the larger bore engine, twin exhaust systems are fitted. The exhaust manifolds have always been of two castings, the down pipes from which have merged before entering the first silencer. On the new model, however, each exhaust manifold for three cylinders has its individual exhaust system, terminating in one of the twin tail pipes at the rear of the chassis.

Two newcomers to Earls Court, the two V-twelve Ferrari models, were full of interest. On the 2·6-litre model a dual downdraught Weber carburettor is mounted upon an aluminium induction casting almost as long as the cylinder heads. Contained within this casting are the two main induction galleries, each fed by one barrel of the twin carburettor. From each gallery three branches fall to the three siamesed inlet ports on the inside of each cylinder head. These port branches are in two parts, the upper part being cast integral with the induction manifold while the lower part is formed by a separate trouser-piece casting, bearing two tracts. There are, therefore, three of these trouser-piece castings forming the connection between the main gallery tracts and the inlet ports in the cylinder heads.

The port branches at each end of each main induction gallery fall straight from the floor of their individual galleries but this cannot be done with the centre ports as they are opposite the throttle outlets of the carburettor. Instead, the two centre ports are taken from the outside wall of each gallery tract, so as to avoid these ports taking more than their fair share of the mixture issuing from the carburettor barrels. The manifold casting is also cored to form a coolant jacket round the gallery tracts, so providing heat for the mixture. Two rubber coolant pipes, one from the rear of each cylinder head, enter the rear of the manifold casting and a rubber pipe of larger dimensions leads from the front of the manifold to the radiator. Thus the main outlet



Ferrari water-heated induction system



Three dual carburettors on the 4·1-litre Ferrari

of the coolant from the cylinder heads is by way of the manifold jacket.

The dual downdraught Weber carburettor bears the finished look of an aircraft instrument, and the throttle system is reminiscent also of aircraft practice. Control of the throttles is by a single shaft and the throttles are geared together so that they open in opposite directions with symmetrical angularity relative to the galleries.

Cold starting is by a small auxiliary starting carburettor operated by a lever-controlled plunger. Fitted to the air intake of the carburettor is a tee, with the upper limbs curved downwards on each side and fitted with a small round air silencer. Two mechanical fuel pumps are employed, one being located at the front of each cylinder head, and the delivery pipes are joined about 12 in forward of the carburettor. There is a separate bowl-type petrol filter on the suction side of each pump, in addition to a filter built into each pump on the delivery side.

Still more impressive is the carburation system of the 4·1-litre Ferrari, claimed to develop 200 b.h.p. at 4,700 r.p.m. The mixture is supplied by three dual downdraught Weber carburettors of a similar pattern to that used on the 2·6-litre model. The induction manifold follows the general design of that of the smaller engine except for the fact that each longitudinal gallery, instead of being fed by a single throttle barrel, is now fed by three barrels. There is some difference also in the arrangement of the port branch construction. In the 4·1-litre model they are not separate items but are formed in a single casting the same length as the main induction manifold, to which it is bolted. A coolant channel passes right through the port branch casting and this, as on the smaller model, forms the main outlet of coolant from the cylinder heads to the radiator.

Here again, twin fuel pumps are used, the delivery from each joins in a pipe common to the three carburettors. Each carburettor carries a tee fitted with twin air silencers, as before. The throttle control is different, however. A long shaft on the right-hand side of the engine carries three levers, which are connected to the three throttle levers by link rods.

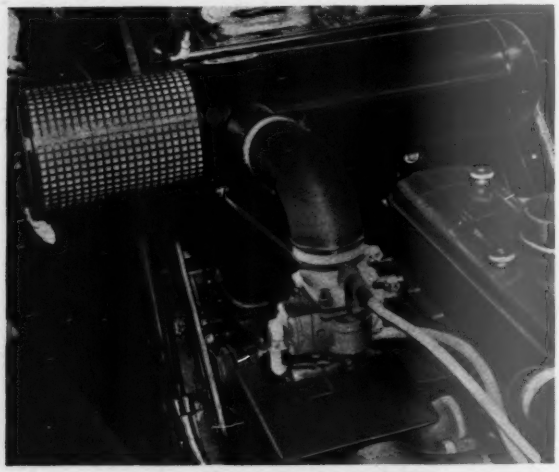
On the special version of the 2-litre Lancia Aurelia, the Gran-Turismo, some modifications have been made to the carburation system. Instead of the special dual downdraught Solex carburettor mounted on the standard engine, two separate Weber instruments are now fitted. They are offset in relation to one another, so as to be symmetrical with each induction gallery; the right-hand carburettor is thus some 2 in farther forward than the left-hand one. As with the standard engine, the two three-port induction manifolds are arranged between, and the exhaust manifolds outside the cylinders. A large and rather shallow circular air silencer is mounted above the carburettors.

Much in the public eye recently as a winner of races and trials, the Jaguar XK120 is powered by the now-famous six-cylinder engine that, with a different compression ratio, is employed in the record-breaking XK120C. A similar version of the same engine is fitted in the MK VII saloon, shown for the first time last year.

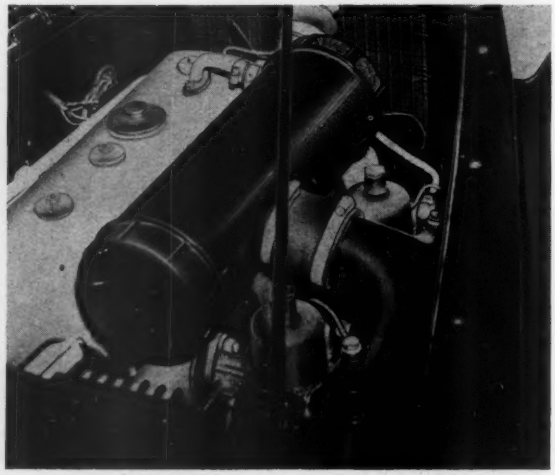
Fed by a pair of horizontal S.U. carburettors, the induction manifold is an aluminium casting; the passages being arranged on the straight-rake principle with six separate branches feeding individual ports in the cylinder head. The main gallery tract and the branches are of rectangular section, and the manifold is heated over the whole of its length by a jacket through which flows coolant from the cylinder head. A rather unusual spacing is employed between the induction ports. The two centre ports are close together, there is a fairly wide space between Nos. 2 and 3, and 4 and 5, and a smaller space between Nos. 1 and 2, and 5 and 6. As is usual with this form of twin carburettor system, a balance orifice is located in the centre of the gallery tract.

Cold starting is effected by an S.U. automatic starting system, the discharge from which takes place inside the balance orifice. The system comprises a small auxiliary starting carburettor which contains a metering needle working in an orifice; the needle position being controlled by a solenoid built into the unit. A thermostatically-controlled electric switch is located in the cylinder head and is thus responsive to coolant temperatures. It is arranged to operate the solenoid when the engine is cold and raise the metering needle and so feed a rich mixture of fuel and air into the centre of the induction gallery. When the engine has attained its working temperature the thermostat opens the switch and the starting carburettor automatically goes out of action. A cast aluminium Y-piece connects the intakes of the carburettors with the Vokes air silencer, which is mounted above the manifold with its air intake at the rear. On the left side of the engine, the exhaust system is composed of two separate, three-port manifolds, the pipes from which lead down and join one another before passing into the silencer.

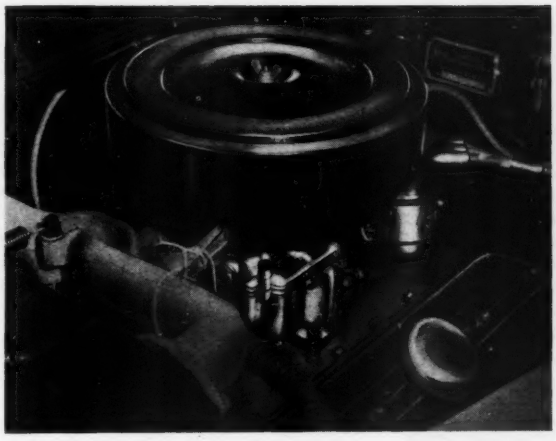
A recent addition to the Daimler range, the new 3-litre Regency is



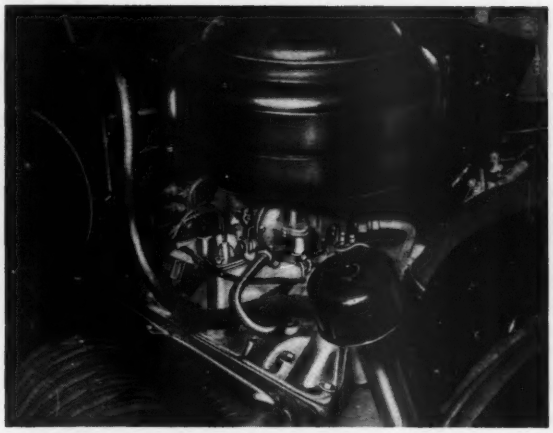
Heat shield on the Renault Frégate



Float chamber venting on Daimler Regency



Twin carburettors on the Lancia Gran Turismo



Multiple induction manifold on the Chrysler Firepower

fitted with an entirely new engine. The carburation system consists of two S.U. horizontal carburettors feeding a six-port induction manifold located above the six-port exhaust; both manifolds being mounted on the left side of the engine. In common with previous Daimler designs, the induction manifold is of cast aluminium and water jacketed over the whole of its length. While the cross-section of the internal gallery tract is circular, that of the external manifold casting is D-shaped, with the flat side facing away from the engine. Instead of the six branches rising slightly from gallery to cylinder head, as with the larger DE-27 model, the branches fall some two inches. Engine coolant for heating the water jacket is supplied by means of two copper pipes at the front end of the manifold casting. One pipe comes from the water pump, while the other leads to the thermostat housing.

The porting arrangement differs from the engine of the 2½-litre and is similar to that of the larger DE-27 model. On the 3-litre the outermost ports of the cylinder head are for the exhaust. Moving inwards from each end, the next two ports are inlets arranged close together. Next come two exhaust ports, close together, and finally the two central inlet ports. The two horizontal S.U. carburettors are placed between the inlet branches of cylinders 2 and 3, and 4 and 5, and a balance orifice is provided in the centre of the tract. A large A.C. air silencer is positioned above the manifolds with a cast aluminium Y-piece making connection with the intakes of the carburettors. From the front of the valve rocker cover a breather tube leads into the air entry end of the air silencer, and so imposes a slight depression upon the crankcase. The float chamber of each carburettor is vented into the air intake casting by means of a small-diameter tube, and a similar tube vents the jet well of the carburettor as a precaution against vapour lock.

Twin three-port exhaust manifolds are employed, the off-take of each being towards the centre of the engine and below the port branches of cylinder Nos. 3 and 4 respectively. The down pipes merge together and the exhaust gases pass into the first silencer, arranged under the driver's seat, and then into another located under the rear compartment.

Except for hemispherical combustion spaces and overhead valve gear the new Chrysler Firepower engine follows current American practice in V-eight design. These features, of course, are not novel in this country. The cylinder heads are arranged with the four separate inlet ports on the inside, and the four exhaust ports on the outside. Cylinder banks are at 90 deg and bridging the vee is a massive casting containing the induction tracts, the exhaust passages for the hot spot, and also the coolant channels from each cylinder head. The large coolant outlet houses the thermostat.

A single, twin-choke, dual down-draught Carter carburettor is mounted in the centre of the induction casting, the passages being so arranged that the right-hand throttle barrel feeds cylinders 1 and 4 on the right and cylinders 2 and 3 on the left. Conversely, the left-hand barrel supplies cylinders 2 and 3 on the right, and cylinders 1 and 4 on the left. As the induction tracts have to pass over or under one another they are at different levels, the fore-and-aft gallery fed by the right-hand barrel being higher than the left-hand one by the height of the tract itself. Thus one riser is nearly twice the depth of the other. This, however, is common American practice with V-eight engines and no ill effect appears to result.

The area around the riser and gallery tee junctions of both tracts is surrounded by an exhaust-heated jacket, fed from a supplementary exhaust port on each cylinder head. Controlled by a thermostatic valve on the right-hand side of the engine, exhaust gas flows through the hot-spot jacket when the engine is cold. The valve is of the usual flap type, housed in a small casting attached to the base of the right-hand side exhaust manifold. An interesting feature of the carburettor is the inclusion of water heating of the throttle body, as a preventive against icing under critical conditions of temperature and humidity. This is done by providing channels in the throttle body casting which receive coolant liquid through orifices in the carburettor and induction manifold flanges.

Modifications have been made to the automatic choke to provide better operation under various conditions. This is of the conventional American hot-air type with an off-set strangler. Instead of the common arrangement in which the air heater tube passes straight through the exhaust manifold from top to bottom, in this case the tube is U-shaped and presents about twice the usual length of tube to the exhaust heat. Incorporated in the automatic choke system on the carburettor is an automatic fast-idle, which ensures that the engine is running at a speed sufficient to prevent stalling when cold. A large cylindrical air cleaner is mounted directly on top of the carburettor intake. Placed just behind the fan, on the right-side front of the engine and rather low down, is the mechanical fuel pump. It was affirmed that this position was chosen as being the most favourable for the avoidance of vapour troubles.

CLUTCHES

Virtual Standardization of the Single-Disc Type

WITH the single exception of the American Hudson cars which have cork-faced clutches running in oil, the single-disc, dry-plate clutch is completely standard. Perhaps a similar exception should be made in the case of the top-gear locking clutch fitted to the Packard automatic transmission; this of necessity working in the special fluid on which the transmission operates and having cork facings.

Universally-jointed clutch withdrawal shaft on Rover chassis

The several Continental cars shown with Cotal gearboxes also employ dry-plate, single-disc clutches for connecting the gearbox to the engine. It is reported that some of these makers are considering the use of a fluid flywheel, largely with the idea of cushioning the change of the Cotal gearbox itself. We feel that in some cases their hopes may be disappointed, as at high speeds a fluid flywheel is practically a solid coupling. As experience with Wilson gearboxes shows, a fluid coupling does not provide an effective cushion for a rapid, and possibly ill-judged, gear change.

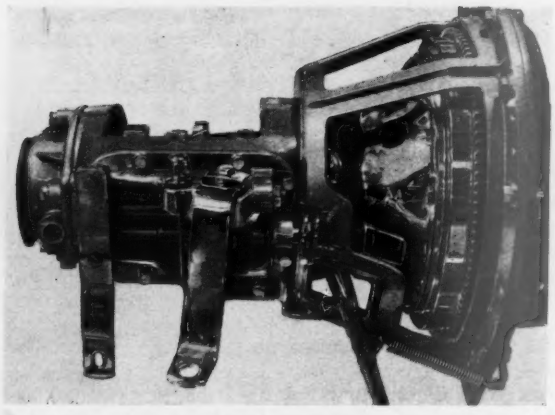
Noticeable in the design of clutches is the use of discs which are elastic right up to the point of final engagement instead of having first-intention springs only under the facings. The Borglite discs, now fitted by Borg and Beck, have the steel discs to which the facings are riveted sub-divided into segments connected to the centre by narrow radial arms. The segments are crimped in such a way as to give both first-intention and full-load cushioning.

Though not used, as far as we know, in production, the Newton cushioned clutch disc is a good example of this type and is largely fitted as a service replacement. In this there are two steel discs with one facing riveted to each. The shouldered rivets on one plate project through clearance holes in the other, while Belleville washers are fitted round each rivet, giving an even distribution of pressure conducive to smooth engagement and long life.

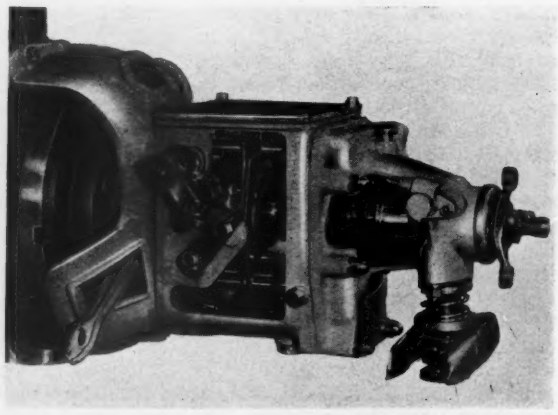
The elasticity of the clutch disc is, we think, rather more important now than formerly, since in so many cars the engagement of the clutch is affected, if only slightly, by end-movement of the engine. Elasticity in the clutch disc itself will largely discount the effects of such slight movements.

Since clutch pedals are no longer fitted to the power unit, the pedal cross-shaft has practically vanished. Its place is being taken by a lever having two jaws to carry the withdrawal carbon or to engage the withdrawal ball-race, a fulcrum, often of spherical form, and a projecting arm coupled by cable or rod to the pedal.

There are still a few examples of floating, compensating links which permit oscillatory and fore-and-aft movement of the power unit without affecting clutch engagement, but these are becoming more rare. It is found that if the lateral withdrawal lever has a mechanical advantage of about 3 : 1, and providing the power unit is located fore-and-aft by a fairly stiff rubber sandwich, no further refinement is necessary. At the same time, the hydraulic clutch operation fitted to the Ford Consul and Zephyr models represents the ideal in that it is completely unaffected by power unit movements. This system, together with the pendant pedal arrangement which has always seemed to us highly



Clutch withdrawal and gear striking levers on Hillman



Clutch and gearbox of Fiat 1400

commendable, makes a most attractive scheme. At the same time we think it possible that, especially when a car has been left standing in a high temperature, there may be rather more "stiction" of the rubbers of the master and operating cylinders than is conducive to consistent clutch operation. Here again, the commonsense solution is to provide a certain amount of elasticity in the connection from the clutch-operating cylinder to the clutch pressure plate. In the case of the Ford models this is, possibly, deliberately achieved by making the withdrawal lever a relatively flexible pressing. Flexibility of the clutch disc itself is in this case also an advantage.

English cars practically standardize carbon ring withdrawal bearings; the new Morganite carbon rings representing a great advance in the behaviour of this important part. The Americans continue to use ball bearings, as do the Rover Company in England, where the journal-type withdrawal race is enclosed in an extension of the gearbox and is continuously lubricated.

The Lancia Aurelia was last year an example of a clutch with direct operation of the pressure plate without intermediate levers. This year the Ferrari chassis, pre-eminently a sporting and racing model running at exceptionally high engine speeds, has a single-disc clutch, the cast-iron pressure plate of which houses a journal-type withdrawal bearing. To the inner race of this is secured, by a ring nut, a rearwardly extending sleeve having a hardened flange at its back and engaged by the two claws of the long withdrawal lever. This is linked to a very short arm on the clutch-pedal shaft by a short piece of cable. The considerable multiplication necessary between the pressure plate and the pedal has, of course, to be obtained in one stage, but the engine is located so firmly in a fore-and-aft direction that the high loading and short travel of the connecting cable is of little consequence.

GEARBOXES

Little Change. No New Examples of Automatic Transmissions

AUTOMATIC transmissions of the torque converter type were shown in exactly the same variety as at last year's Show. These range from the two-phase torque converter combined with a two-speed planetary gear, as used on General Motors products, to the three-speed, epicyclic gearbox associated with a torque converter and having automatic change to intermediate ratio, fitted to the Ford-built vehicles.

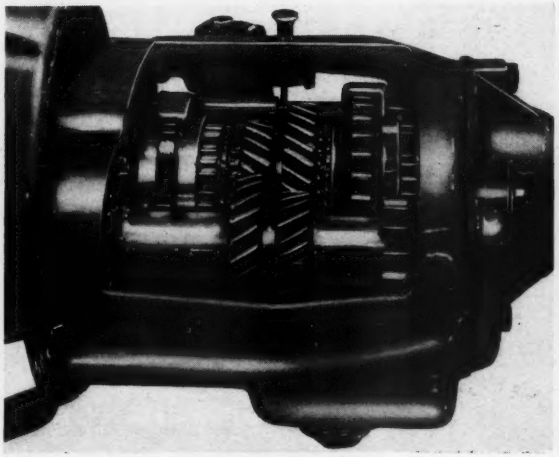
Packard showed again their variant of the first system, in which an oil-operated disc clutch locks the transmission solid for cruising, while Studebaker exhibited their version of the second system in which an oil-operated clutch gives direct drive, but when this is released the power comes through the torque converter and the intermediate ratio of the three-speed epicyclic gearbox. In other words, the Studebaker torque converter is never in action with direct drive in the gearbox.

With the single exception of the Dyna Panhard, which offered a Kreis centrifugal and frictionally engaged three-speed automatic gearbox as an optional extra, there was not a single automatic transmission of any kind on any of the British or Continental cars shown.

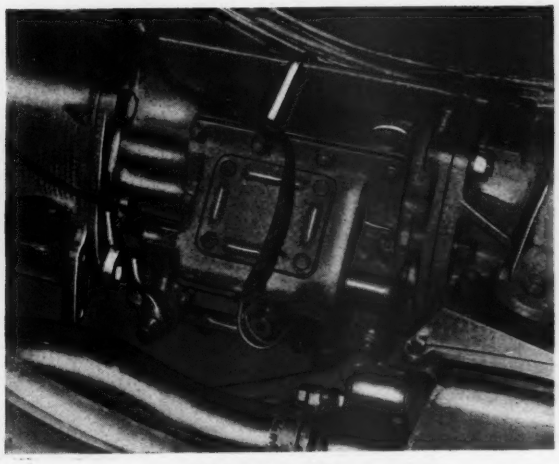
The Wilson gearbox is employed on Lanchester and Daimler cars, and as an alternative on the Armstrong-Siddeley models, while the Cotal four-speed epicyclic gearbox with electro-magnetic clutches was offered by several French makers. Triumph and Standard also offered the DeNormanville overdrive as an optional extra. This, it will be remembered, has been altered in ratio so that it now gives a step-up of 1·285 : 1, the overall engine to rear wheel ratios being 4·625 : 1 normal and 3·6 : 1 overdrive. This increase of ratio makes for greater silence and economy, but slightly reduces the maximum speed available on overdrive since, unless the wind happens to be very favourable, the engine never quite reaches the peak of the power curve on overdrive ratio.

Whatever the advantages of the converter type of automatic transmission, and they are many, it must be admitted that they are distinctly less efficient, put up the petrol consumption of a car by 10 to 15 per cent, require fairly frequent replacement of the very expensive operating fluid, and do not, as a rule, give a performance quite equal to that of a four-speed gearbox in the hands of a skilled driver. Their effortless performance is most apparent in vehicles having an abnormally high power : weight ratio, such as motorists in this country can neither afford to buy nor operate.

There are no notable changes in ordinary gearboxes. Four-speed units are practically standard on the



Gearbox of Hillman Minx



Striking lever of Rover gearbox

Austin Seven gearbox

Continent and are common in England, though it should be observed that Standard, Triumph, Vauxhall and Ford continue to fit three-speed boxes. Five-speed boxes are only to be found on vehicles of the sporting type, of which the Ferrari 212 Export model is a new example.

In contradistinction to the Lancia Aurelia which has one gear train outside the main walls of the box, the Ferrari gets all its five speeds between the front and rear bearings. Fifth speed is an overdrive and is located at the rear of the box, being engaged by a non-synchronized tooth clutch struck by a fork formed integral with that for the reverse idler. The gate, therefore, has three slots, with overdrive opposite reverse to one side. Fourth, third and second speeds are synchronized, while first speed is engaged by a sliding wheel. A gear-wheel pump on the layshaft lubricates the bushes of the idle wheels. Ratios are exceedingly close as the vehicle, to all intents and purposes, is a racing car.

Though low cost of production has been one of the dominating features in the design of the new Austin Seven, the makers have very wisely provided a four-speed gearbox. This is of quite normal construction with baulked synchromesh on top, third and second gear. The striking rods come low down on the offside of the gearbox and are engaged by a change-speed lever mounted in the gearbox rear extension to the left of the centre line.

The Borg-Warner type synchromesh is now almost standard and the new Bristol gearbox embodies this mechanism in place of the non-positive type formerly used.

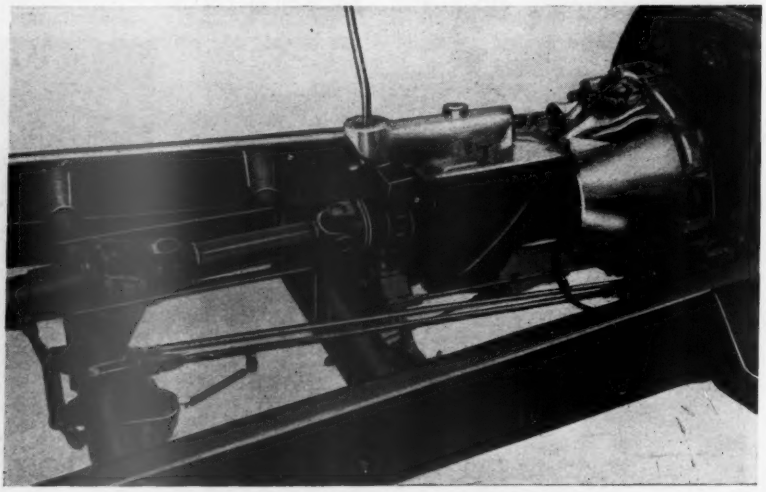
Much detail improvement has been made in column control mechanism, chiefly by the stiffening up of weak details and the elimination of rattle. A good example of this is the mounting of the change-speed arm on the Ford Consul and Prefect cars, where a close-fitting rubber sleeve surrounds the pin joint on which the lever swings in a vertical direction to select the gears.

Where four speeds are fitted, a third selector rod is always used for reverse since, quite apart from the undesirable length of a through-going, four-speed and reverse gearbox, drivers of column-control vehicles will not accept the long travel necessary to engage reverse by passing through first speed. Striking of the gears, in this case, is always done by rodwork, while the selecting in the box is frequently by flexible cable.

Where three speeds and reverse only are required, connection to the gearbox is always by rods, these frequently having pin joints with rubber-mounted bushes, which give the effect of a ball-joint and eliminate rattle. Selection is either by external dogs, as in the Vauxhall column control, or by a round pin or round-ended key engaging slots in the opposed bosses of the two striking levers on the columns. In one case, these levers are supported on the change-speed column spindle and kept in position by bearings supporting the spindle, which come immediately behind them. The slotted bosses are separated by a tubular distance piece which encloses the selecting parts. In another instance, the two column striking levers have their opposed bosses, cross-milled to take the key, screwed into a threaded bracket which serves to support and to enclose the mechanism.

No particular trouble appears to have been experienced in the connection between column control and the gearbox as a consequence of power unit oscillation, but some makers seem to go to much more trouble than others to reduce the effects of this. The Standard Company, for instance, continue their practice of making the final connection to the gearbox by short, universal-jointed shafts, the outer ends of which are carried by the frame of the car and are connected by rods to the column control. A similar method is followed in the new Vauxhall car, but most firms appear to get satisfactory results by rodwork going direct from the column control to arms on the gearbox. This, it may be conjectured, is largely a question of the flexibility of the rubber mounting and the leverage ratios employed. The longer the travel of the rodwork the less, obviously, is the effect of engine oscillation on gear selection and engagement.

The forward mounting of power



Gearbox and torque-tub anchorage on 2½-litre Riley

units necessitates the rearward extensions on the gearboxes, if propeller shafts are to run without vibration. In these days, when a low floor line is regarded as an essential, the propeller shaft tube is likely to be rather smaller in diameter than is desirable. As might be expected, it has been found that these rearward extensions do not always solve the problem. A shaft that runs perfectly smoothly on the balancing machine may behave quite erratically when mounted in the car. This, presumably, is due to the lack of stiffness in the mounting of the projecting extension and is especially noticeable when the rear power unit mounting pads are located well forward and are fairly soft. One or two cars were observed which have had additional supports added under the end of the gearbox extensions since last year.

The lubrication of the slip splines from the gearbox is now accepted procedure, and both Oilite and white-metalled steel bushes are used to support the sliding member. It was good to observe that over-lapping dust shields are almost universally employed. This point is of particular importance since the seal has to cope with the difficult conditions of a rapidly rotating shaft subject to considerable end travel at the same time.

The demand for a low floor line has resulted in axle noses being tipped downward, an arrangement which, in some cases, gives bad distribution of the working angles between the two ends of the joint. Very convenient assistance, however, is afforded where the rear springs are mounted eccentrically, as, for example, on the Triumph Mayflower. The axle nose of this car points downwards appreciably, but on the rebound the eccentric spring lifts the nose of the axle, so that the angle of the rear joint is not as great as might be expected.

Needle-roller bearing joints are now almost universal and intermediate bearings are being more commonly used as an alternative to the gearbox extension. While the standard equipment at this point is a light-type ball bearing in a housing having laterally extending sheet steel lugs carried by rubber bushes, development work is proceeding in the use of sintered bronze bearings with oil reservoir lubrication as a substitute for a ball bearing. Joints are mostly of the Hardy Spicer type, though a number of the Continental cars had Mechanics universals.

It is interesting to observe that propeller shaft vibration troubles experienced on some cars have been alleviated by setting the joint forks on the propeller shaft tube out of plane, the forces set up by this deliberate error happening, in some cases, to counteract the lateral forces due to angularity.

REAR AXLES

Hypoid Bevels and Semi-floating Axles Predominate

HYPOID bevels, generally cut on the "formate" system, are used in every instance where the designer has a free hand. Exceptions occur only in such assemblies as the rear-engined Porsche and the 750 Renault where the driving shaft of the forward-mounted gearbox passes over the differential box and the downward offset of a hypoid bevel pinion would make the gearbox centres uneconomically large.

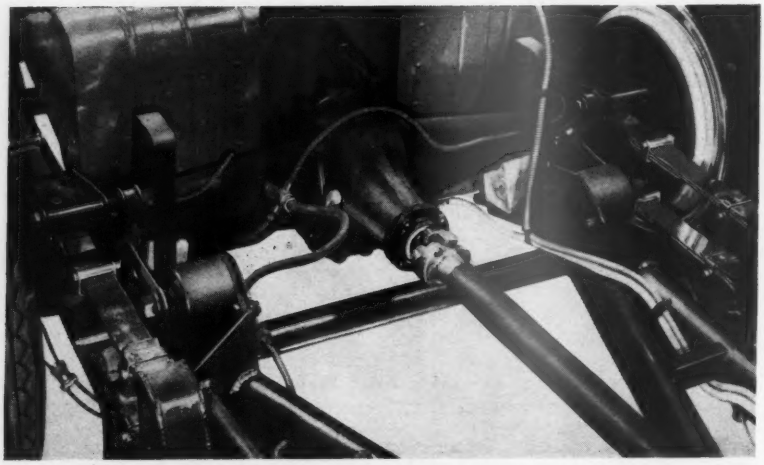
One other example of a spiral bevel is to be found on one of the competition-type Allards. Here the pinion is at the rear and the drive is by a shaft passing under the differential box and coupled to the pinion by a pair of spur wheels in a casing with an easily-accessible cover which retains the wheels in position. The same considerations apply as in the rear-engined layouts, only in the Allard the appropriate pinion offset would be upwards and would make the spur gears so large that ground-clearance would be prejudiced. The bevel gear ratio in this instance is midway in the range of ratios likely to be used for competition work. By interchanging the spur wheels, an operation which can be done at the roadside, two useful alternative ratios are available, with as many more as desired by supplying additional pairs of gears.

Attention to the rigidity of pinion and differential-box mounting has permitted the employment of crown wheels of a size that would have been considered dangerously small a few years ago. Several factors contribute to this tendency, in particular the use of tyres of very small rolling radius on rims as small as 13 in diameter in some cases. Again, the forward mounting of power units, coupled with inter-axle seating has reduced rear-wheel loads to a degree that greatly relieves the axle gearing and differential shafts by permitting wheel-spin. It would appear that some care should be exercised in using such vehicles with delivery-van or station-waggon bodywork, in which rear-axle loads far beyond the design figures are extremely likely.

In changing from the banjo-axle with close-spaced differential bearings to a very stiff casing of the Salisbury type with wide-spread taper roller bearings, the Vauxhall designers have been able to reduce the crown-wheel diameter to 6·125 in on a car having 5·60×15 tyres, an axle-ration of 4·625 : 1 and a kerb weight of 2,300 lb. This has involved keeping the two-pinion differential on the small side and the use of small differential shafts made from ground bar, heat-treated to 100 tons tensile. Stress-raisers are dealt with by using splines of fine pitch, with the shaft reduced locally to bottom spline diameter.

At the outer end of the semi-floating differential shafts the usual stress-raising shoulder behind the wheel

Rear axle drive with ratio change-wheels on competition Allard



Rear axle and frame details of Ferrari 212 chassis

bearing is eliminated by the use of a separate sleeve, made a moderate interference fit on the parallel shaft, and intended to move inwards on final assembly of the hub on the taper axle-end. A further stress-raiser has been eliminated by extending the taper bore of the hub well past the large end of the taper on the shaft.

Another interesting detail is the method of locking the nuts securing the pinion shaft flange, and the wheel hubs, by a process of driving a thin lip on the nut into the ends of a wide cross-slot in the end of the shaft, a punch and hammer being the tools employed. As compared with a castellated nut and split-pin, this arrangement gives infinite graduation, a valuable point in setting the pinion-bearing pre-load, for example.

Axle-casings of the Salisbury type, in which the differential bearing housings are half-buried in the casing mass and the end-thrust is taken on a continuous facing on the casing, are to be found on several cars. In the Vauxhall layout the end thrust of the outer races of the differential bearings is taken on the inner ends of the axle tubes which are pressed and dowelled in position. Bearing adjustment is by accommodation rings behind the outer races, which can be fitted after assembly and do not call for the spreading of the casing to fit the differential customary on the Salisbury axle where the shims come behind the inner races and must be fitted before assembly.

The banjo axle casing is by no means dead, though not so common as it is on American vehicles. It will be remembered, Ford changed over from a trumpet axle to the banjo last year, the casing being flash-welded together on the vertical-longitudinal plane in order to save scrap by alternating the blanking of the half-arms. Much development work has been done on a modification of the Scott expanded-tube construction using rolled-up pressings, but recent shortages of sheet metal have forced a return to the tubular construction by one firm of pressing specialists.

On the other hand the Nuffield organization are, it is understood, extending their standardization of the vertically-split casing with tubes by adopting this construction in place of the banjo axle on the Riley cars. The Ferrari 212 Export chassis has a type of axle casing once very popular, in which the differential housing, cast in aluminium alloy, is split on the vertical and cross plane to take the differential bearings, the casing being completed by trumpets with oval flanges.

In wheel mounting there is a decided preference for the semi-floating arrangement. Notable exceptions are the Austin Motor Co., who employ three-quarter floating axles, even on the New Austin Seven, and the Ford Co. on the Consul and Zephyr.

Nearly all the semi-floating axles arrange the end-location of the differential shafts from the wheel bearings, so that they will not pull out in the event of a fracture of a differential spline. Since all modern differential shafts are designed on a basis of the splined end failing by fatigue before the wheel-carrying portion, the safety of the public would seem to be equally well safeguarded by both semi- and three-quarter floating arrangements.

A somewhat surprising exception to this rule is to be found in the case of the Buick axles. Here the employment of a banjo axle would seem to preclude end location of the differential shafts from the differential side wheels. However, the exercise of considerable ingenuity, perhaps rather misplaced, has made this possible. The outer ends of the flanged differential shafts are carried on parallel-roller bearings giving no end location: the axle is assembled with the differential cross-pin and pinions omitted. The differential shafts are then inserted into the side wheels and pushed inwards beyond their normal position. C-washers are then fitted to the grooved inner ends of the shafts, which are then pulled out until the C-washers seat in recesses in the differential side wheels. The fitting of the pinion and cross-pin, with its square distance-piece, then prevents the shafts from working inwards again.

In semi-floating axles where both hub and wheel bearing are fitted from the same side, the problem of securing both with one nut has several solutions. One, involving the fitting of the hub on a taper and allowing it to carry with it the wheel bearing and a moderately tight location sleeve behind it, has already been described in connection with the Vauxhall axle.

The axles on the various Nuffield products have the wheel bearing fitting against a shoulder integral with the differential shaft. The hub slides on splines with the interposition of a split conical ring, having a cylindrical fit on the shaft and a conical bearing in the hub, its flat face bearing on the inner race of the ball bearing. On the Triumph Mayflower the arrangement is similar, but the splined hub abuts directly on the ball bearing. The split conical ring, which stops continual chafing of the splines, comes on the outside hub, under the securing nut.

Examples are still to be found of semi-floating shafts with upset flanges for the wheel and brake drums and with the ball bearing secured by a screw thread on the inside. Careful tests made some time ago by the Standard Motor Co. showed that the stress-raising influence of the thread on the rotating shaft is negligible, far less in fact than that of the retaining shoulder for the inner race, even where a large radius is employed.

Independent rear wheel suspension is slowly gaining ground, Lancia, Renault 750, Allard and Lagonda being examples shown last year. At this year's Show the new 2-litre Renault has independent rear suspension, although it has not a rear-mounted engine of the 750 type which makes independent suspension obligatory.

Only Lancia uses a "pot" universal at one end of each driving shaft. All others employ standard needle-roller joints with conventional slip-splines. The Lagonda rear drive is of interest as employing the centre of a standard Salisbury axle with the axle tubes omitted.

FRONT SUSPENSION AND STEERING

Increased Use of Rubber Bushes for Suspension Pivots

OF English cars the only one still fitting a beam front axle on leaf springs is the 2-litre A.C. and among Continental products the only example so equipped was a Renault model which is largely intended for use as an estate waggon or delivery van. Last year, it will be remembered, Sunbeam-Talbot changed over from a beam axle to the wishbone suspension with threaded steel joints standard on the other products of the Rootes group.

There was one change in I.F.S. practice. The new Vauxhall models have dropped the modified Dubonnet suspension, using torsion bars with toggle-operated softening springs, in favour of wishbone suspension on American lines with screwed steel joints. The upper wishbones are simple pressings, the lower one is also a one-piece job but the jaw which takes the lower end of the steering swivel is reinforced by bending round and welding together the two webs that carry the outer joint bushes. These have at all points, the usual obtuse external threads which cut their own bearing in the bosses formed in the webs by a plunging operation.

There is no separate swivel column, a spindle pressed into the lower end of swivel itself, working in a bronze bush, in a cross-piece that has screwed spindles working in the wishbone bushes. The upper swivel bearing takes the form of a ball joint, the socket of which is secured by an overhanging shank passing through the two webs of the upper wishbone. No camber or castor adjustment is provided, but the front cross-member which forms the foundation of the suspension unit is pre-stressed before drilling the suspension pivot holes.

The coil springs have ground upper ends but at the bottom finish with a tail which serves to locate the spring in the lower wishbone pan. This is found to be important since, owing to the angular movement of the wishbone, the effective "rate" of the spring depends on the position of its finishing turn. The telescopic shock absorbers are within the coil springs and there is a large hole in the wishbone pan, through which the absorber can be removed after passing the upper attachment washer, which has two flats, through the hole.

An important feature is the provision of large rubber pads between the suspension cross-member and the outriggers if the integral body and chassis. These pads constitute a substitute for the cushioning normally furnished by rubber bushes in the suspension joints, but without the possible errors in geometry, brake shudder and steering vagaries that other arrangements can sometimes engender.

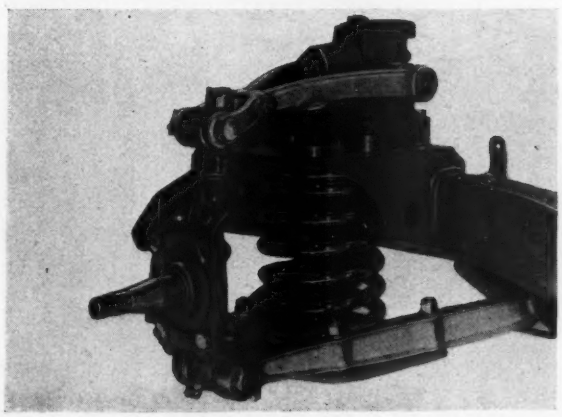
The new Austin Seven has wishbone suspension, also without a separate swivel column. Metalastik bonded-cone bushes are used for the inner ends of the lower wishbones, with metal joints and cross-piece similar to the Vauxhall at the swivel end. Instead of a ball joint at the upper end, the swivel turns in a plain bush. Articulation of the single shock absorber arm, which acts as the upper wishbone, is by another bonded-cone rubber bush. There is no doubt that the designers of the Austin Seven are right in introducing a rubber bush at this point. Quite apart from any quietening effect it may have, it will take any misalignment due to deflection of the lower rubber bushes and thus stop bell-mouthing and wear of the upper swivel plain bush.

Changes recently made in the Morris Minor front suspension would seem to confirm this point. Last year's car had plain bushes in the corresponding position for both steering and articulation. This year the second one has been replaced by a Metalastik bonded-cone tube bush.

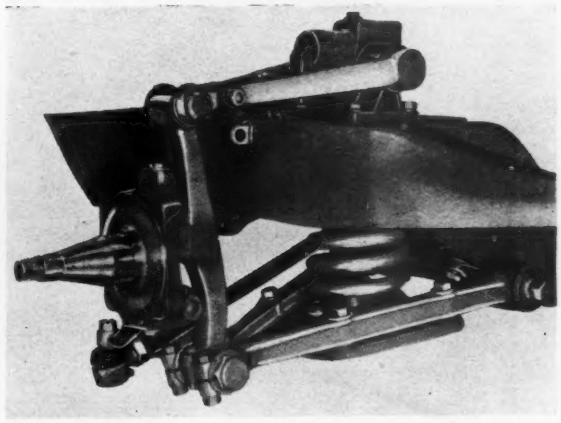
A somewhat similar change has also been made in the Jowett suspension, the plain-bearing upper wishbone having been replaced by one having bonded-cone bushes at all three corners. Advantage has been taken of the changed design to move the upper attachment of the shock absorber on to the stamping that carries the wishbone fulcrum pins. The action is now direct, as distinct from the differential action with much reduced absorber stroke that obtained when the attachment was to an intermediate point of the upper wishbone. A rubber bush is now also used at the lower end of the swivel pin, the lower suspension arm having, as before, parallel rubber bushes with snubber flanges fitted to the tube into which the torsion bar is splined. Camber adustment can be made by shimming the upper wishbone fulcrum stamping against the body structure: castor angle can also be modified by washers on either side of the lower swivel pin articulation bush.

Similar shimming for camber adjustment has always been provided behind the hexagon bars forming the upper wishbone fulcrums on the Humber and Hillman cars. In American practice, camber adjustment is nearly always provided by an eccentric pin in the upper, outer joint and castor adjustment by screwing this same pin along to the nearest turn. English designers often omit any adjustment.

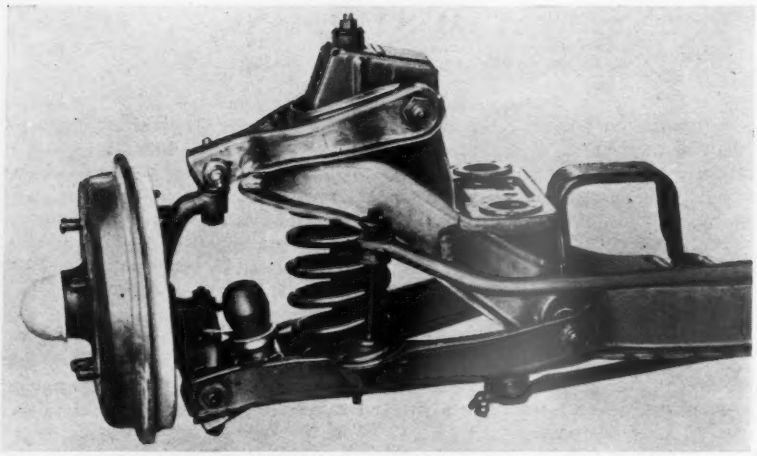
A good exception to this is the



Austin suspension without swivel column



Austin Sheerline suspension with separate swivel column



Vauxhall I.F.S. showing rubber mounting pads on cross-member

Jaguar suspension. Here, camber is set by shims behind the upper wishbone fulcrum stamping. Castor can be adjusted by interchanging shims from side-to-side of the rectangular blocks housing the ball joints which accommodate both steering and articulation movements. These blocks are clamped between the two arms of the wishbone by through-bolts.

The Girling suspension is still fitted to the Rover cars and is also to be found on the new Diamler Regency chassis. The main radius arm is of box section and, as before, is outside the frame and necessarily cranked to clear the road wheel at full lock. On the Rover, the arm runs diagonally under the frame and can, therefore, be quite straight and requires no boxing. With this layout a longer arm is permitted. This appreciably reduces the change in castor angle with spring deflection, which is a feature of this system.

One of the good features of the Girling suspension, in these days of yielding joints and general flexibility in the interest of silence, is that the brake torque is taken direct by the main arm, which is bolted to the swivel. The upper link has nothing to do except control the camber angle and is not subject to the general cross-binding action which occurs in a normal wishbone system when the brakes are applied. Now that designers are realizing the value of offset rear springs to check rear-end lift when braking, the Girling system, which does the same thing at the front, but in the opposite sense, may come in for greater attention.

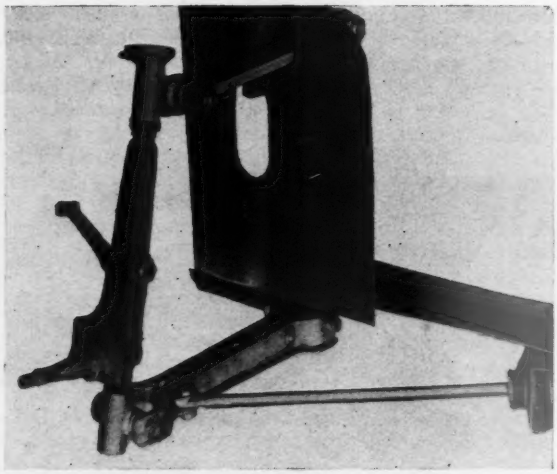
In terms of output, the wishbone and coil spring is most numerous with the torsion bar a good second since all Nuffield products now employ it. It is interesting to observe that torsion-bar splines are in some cases produced by a knurling process. This method is criticized in some quarters but actually the knurling, of fine splines should leave the compressed surface of the metal in a better condition to resist fatigue than any cutting process.

It would be a definite advantage if all cars were provided with torsion bar anchorages adjustable by screw. To avoid trouble with replacements, the usual practice is to omit any pre-stressing of the bars, since this would "hand" them. If reasonably high stresses are worked to, the the initial user has, therefore, to attend to the pre-stressing. It is up to the manufacturers to make the operation of setting up as easy as possible.

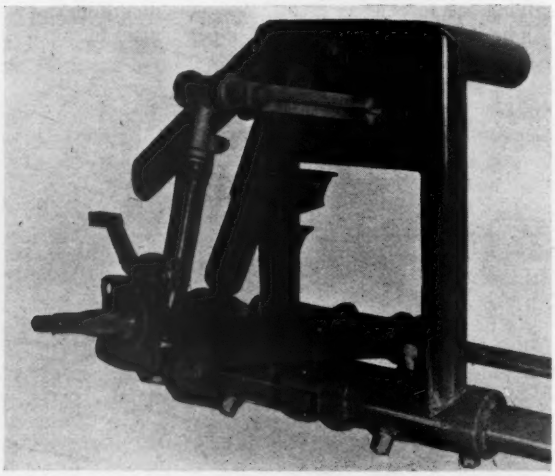
Lanchester continue to use the short, laminated spring, Salter torsion bar, and the Porsche is another example of the same practice. In the second case there are sound manufacturing reasons for its use, since the greater flexibility per inch run enabled the designer to use continuous bars across the car, secure them at the centre, and still get the required deflection with short trailing arms to the steering swivels. In a more conventional chassis, however it would not seem that the shortening of the bar is of any particular advantage and we doubt if the laminated torsion bar makes as economical use of the material as a round section. It would also seem likely to introduce undesirable variations in interleaf friction if rusting should occur. That contingency is circumvented on the Porsche in which the bars are entirely enclosed and work in oil in the cross-tubes that form the foundation of the front suspension assembly.

While on the front-wheel drive Dyna-Panhard leaf springs are used above and below for the front suspension, the Fiat 500 now has a leaf cross-spring as top member of the I.F.S. and wishbone radius rods as bottom members, damping being by telescopic shock absorbers.

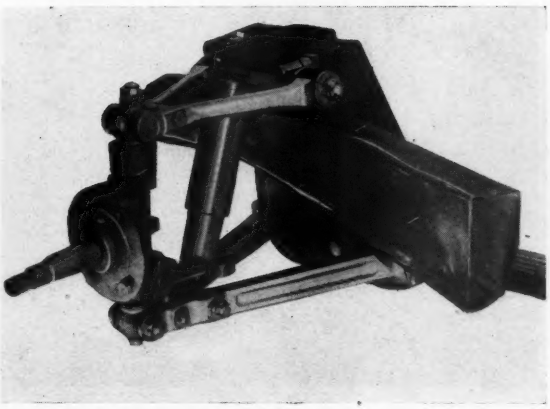
On the Ferrari chassis, which can



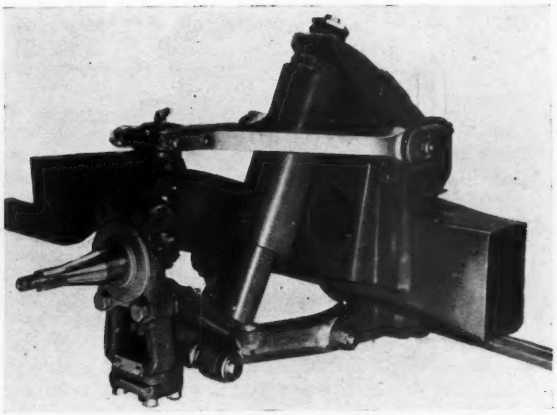
New Morris Minor torsion-bar suspension with rubber-bushed upper joint



New Jowett torsion-bar suspension with rubber-bushed upper lower wishbone



Lanchester suspension with Salter laminated torsion-bar



Jaguar torsion-bar suspension with ball-joints on steering swivels

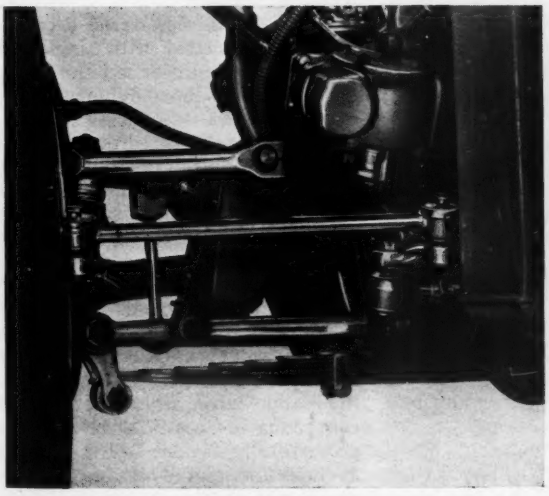
almost be described as a racing vehicle, there is a single leaf spring located low down in front and shackled to the ends of the lower wishbones. These are built up of two stampings united at their outer ends and at an intermediate point by a cross-distance piece to which the link of the vane-type shock absorber is connected. Plain bushes are used throughout, and the upper wishbone stampings are split and clamped to a spindle running in bushes in the elaborate, welded tubular structure which forms the suspension cross-member. Healey and Aston Martin continue the trailing-link system with a torsion bar splined to the lower arms to act as an anti-roll bar.

The unique suspension on the Ford Consul and Zephyr cars appears to have given complete satisfaction since its introduction at last year's Show. The load is transferred to the swivels by direct-acting springs surrounding exceptionally long shock absorbers, the spindles of which are extended into rubber-mounted opposed taper-roller bearings carried high up in the outswept top flanges of the wing valances. To prevent bell-mouthing of the shock-absorber top bushes under the side loads imposed on the spindles in their function as upper guides to the suspension, they are spherically mounted.

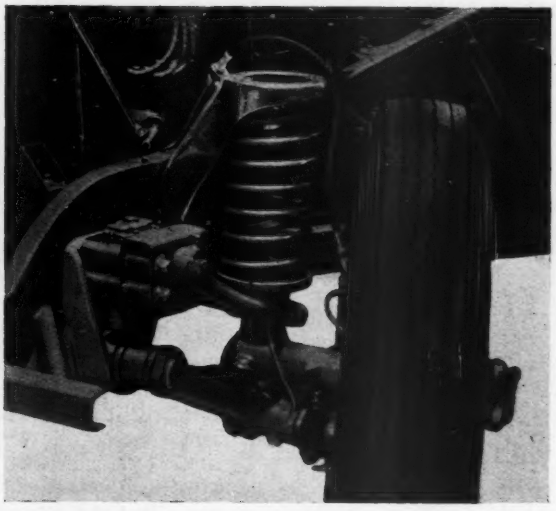
A synthetic-rubber bellows encloses the top of the spindles and is protected by the coil springs from damage by anything thrown up by the front wheels. It would seem, however, that occasional examination of these rubber enclosures in the road-gritting season might be advisable. There would appear to be a possibility, perhaps only remote, of an accumulation of sharp granite chips between the coils of the spring and the corrugations of the bellows. It will be understood that there is no top gland to the shock absorber and any leakage here flows into the bellows and drains back through a hole in the outer tube. Should the bellows be punctured there would then seem to be a possibility of small particles of grit circulating through the absorber mechanism.

Without being hypercritical, it may be pointed out that the rubber bellows in this suspension perform a vital function, whereas those fitted to components such as rack-and-pinion steering gears can be regarded as more or less of a refinement; in short, a torn bellows would do little immediate harm.

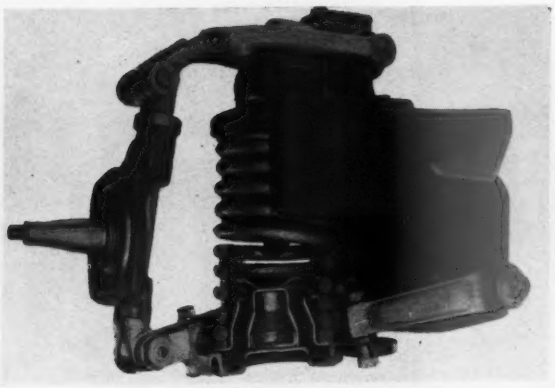
The suspension of the Nash Rambler, at first glance, would appear similar to that of the Ford. While the valance flange carries the coil spring which bears directly on the steering swivel, guiding of the swivel is done by the usual wishbone mechanism below the spring. There seems no particular justification for this design, as compared with the Ford. On the Ford the braking reactions are taken at two points nearly 30 in apart, whereas in the Nash the valance panel has to be stiffened to take the more intense strains set up by the closely-spaced wishbone assembly in addition to being reinforced at the top to take the spring load. In the Ford arrange-



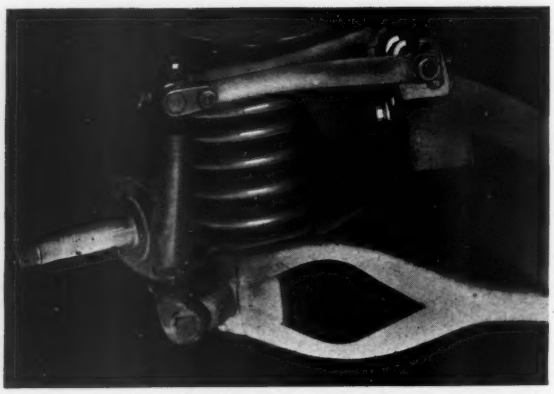
Ferrari wishbone and leaf spring front suspension



Aston Martin trailing link I.F.S.



Metalastik coil spring insulator



Singer SM1500 suspension

ment the local loads are so small that a very light cross-member is adequate to anchor the radius arms at the bottom of the unit, while the lateral forces imposed at the load-carrying roller bearings over two feet above are obviously so small as to require no very special provision beyond that necessary to carry the dead load to the springs.

Before leaving the subject of independent front suspension, which in England has become almost completely rubberized at its joints, some review of the various types of bush employed may be of interest.

The simplest is the Harris-type bush, made either plain or slightly flanged, assembled by hand and pulled up by the end washers until the bush fills the bore tightly and a considerable flange is upset to take end loads. These are used with complete success on the Standard Vanguard and on the M.G. car.

Next in the scale comes a bush moulded with a coned outer surface and pressed on to a distance tube. Here the wishbone arms have, of course, conical bores and the tube acts as a distance piece to determine the preload on the rubber.

A still further type is the Metalastik B.C.T. bush, in which the outside is moulded conical and with a flange and is bonded to a plain distance tube. A more refined arrangement has a conical, flanged bush bonded to a tubular pressing with an integral flange, also bonded behind the rubber, and is identified as the Metalastik bonded-cone bush.

As might be expected, the conical bushes in conical seatings give more rigid end-location than the Harris-type bush and they appear to be more popular. One of the disadvantages of the Harris-type bush is the possibility of improper fitting if oil or grease should get on the washers which strike up the flanges. If this happens there is a possibility of the rubber flowing out at the flange before it has properly filled the bore.

It is interesting to note that, while the cone has been found of great advantage, the bonding of the rubber flange to a flange on the tube is not always desirable. Better life, with less cracking of the rubber at the corner between cone and flange, having in some cases been obtained with the unbonded flange.

It is common practice with some firms to place moulded rubber washers between the coil spring and the spring pan. The Metalastik Co. have now gone a stage further and are offering coil spring insulators, with rubber in shear and compression between two pressings, one of which is flanged to take the spring. Static deflection is quite considerable, at about 0·3 in, and the scheme is claimed to prevent high-frequency vibrations travelling up the spring to the chassis.

All this "rubberization" may seem to be becoming so complicated that there is much to be said for the Vauxhall policy of cutting it all out of the suspension details but insulating the whole cross-member from the vehicle with rubber pads. Not many extra lubrication points are involved, since one nipple could serve each swivel bearing and its adjacent articulation bearing and four wishbone greaser points on each side are not likely to be neglected when there are at least three grease nipples for the steering connections.

Where the location of the power unit permits, the rack-and-pinion steering is reasonably popular, being found on cars differing as widely in handling requirements as the Morris Minor, the Bristol and the Riley 2½-litre. The steering on the 750 Renault still embodies the special features necessary to cope with the wide difference between front and rear axle weights. These include a castor angle of no less than 10 deg, low front-tyre pressure and strong, coil, centring springs on the rack-and-pinion steering.

American cars generally favour what is commonly termed the cam gear, often with roller bearings to the peg and some with two and even three pegs. Buick use a gear with a ball-bearing nut and Kaiser employ worm-and-sector steering. Three French makes were shown with screw-and-nut steering and the worm-and-sector, or complete wheel, was to be found on some Continental vehicles.

On English cars the cam type of gear is the most popular, often, as in the Vauxhall, with a ball-bearing peg. The Burman recirculating-ball, screw-and-nut gear is fitted to Jaguar, Rover and Alvis, while Daimler, among others, use the Marles double-roller steering gear.

In steering linkage, most firms seem to have been able to arrange for a three-piece track rod with single arms on the steering box and the slave lever. In some cases, of which the Ford is an example, the side rods are attached to points some distance along the centre rod, the layout of the Ford suspension fortunately calling for side rods about 15 in long.

In other cases the layout entails double arms on the steering box and on the slave lever. Such an arrangement, it is suggested, should be regarded as a regrettable necessity since, as compared with single-arm arrangements, it introduces the spring of no less than four additional levers into the track-maintaining linkage, while any play in the drop arm shaft or slave arm bearings is multiplied by two in its effect on the tracking of the wheels. Where single arms can be employed, any spring in them does not affect the track, while play in steering box and slave arm bearings has no detrimental influence.

Probably the designer's dream in steering layout is afforded with trailing link front suspension, such as that on the Aston Martin, where the two rods connecting to a central slave lever give geometrically accurate steering so long as the centre joint is offset forward by an amount equal to the radius of the trailing links.

REAR SUSPENSION

Offset Axles and Wider Springs of Fewer Leaves

AN addition to the slowly increasing number of cars with independent rear suspension is the 2-litre Renault. This car has practically, a trailing link suspension, the axis about which the rearwardly-extending arms oscillate on rubber bushes running at a slight dihedral angle only. The arms are built-up of two shallow pressings with vertical webs, coming together at the brake backplate and diverging to the attachment points. The load is carried by coil springs seating on cross-pressings at an intermediate point.

The Renault rear-engined 750 c.c. car has swing-axles moving about gudgeon axes parallel to the longitudinal axis of the vehicle, but all the other independent rear suspensions swing about gudgeon axes arranged some 55 deg to the same axis. These include the Lagonda, the Porsche, and the Lancia Aurelia.

Among special cases is the Allard, with a De Dion axle located by perch bars converging on a ball joint, coil springs seating on the axle ends, and lateral control by a Panhard rod.

The Aston Martin DB2 chassis has its Salisbury rear axle connected to the frame by two radius rods, built up of pressings spaced apart to embrace the attachment lugs under the rear axle tubes, Silentbloc bushes being fitted at both ends. The coil springs seat at an intermediate point on pressings welded to the radius arms, their upper ends coming under the frame "kick-up". The load-carrying members are paralleled by two tubular rods, rubber jointed to lugs welded on the top of the axle tubes and to pins overhanging on the inside of the square, tubular frame members. A very long Panhard rod with rubber bushes gives lateral location.

Buick continue the torque-tube with direct-acting coil springs and Panhard rod, while Riley still fit a torque-tube axle and leaf springs.

Jowett continue their parallel-motion located Salisbury axle with load-carrying torsion bars coupled to one arm on each side. Lateral location is by a rather short Panhard rod with washer-type rubber joints at the ends in place of the bush type employed more generally and, it is considered, preferably, by other makers.

An unusual leaf-spring rear suspension is employed on the Ferrari chassis. Here twin springs are used, one above and one below the axle, which is offset considerably in the forward direction. This layout, which tends to rotate the axle as the springs deflect would seem to conflict with the parallel-motion guidance provided by the anchored front ends of the twin springs. Rubber bushes are fitted and are possibly relied on to absorb tension and compression loads set up by this conflict.

The large majority of rear suspensions are of orthodox design but changes are taking place. Many springs are now being made with fewer leaves of much greater width. The Humber Pullman chassis, for example, now has rear springs 3 in wide, while the new Vauxhall Velox and Wyvern cars have only three leaves in their rear springs, which are 2½ in wide.

Makers who last year fitted rubber pads at the spring tips continue the practice, which appears to have been remarkably successful in reducing interleaf friction while giving a much longer life than pads of friction material. Gaiters are fitted in some cases, these being generally of some plastic fabric with rubber end seals. Many of the gaiters are part-length only, some have grease nipples but most rely on the original filling of grease.

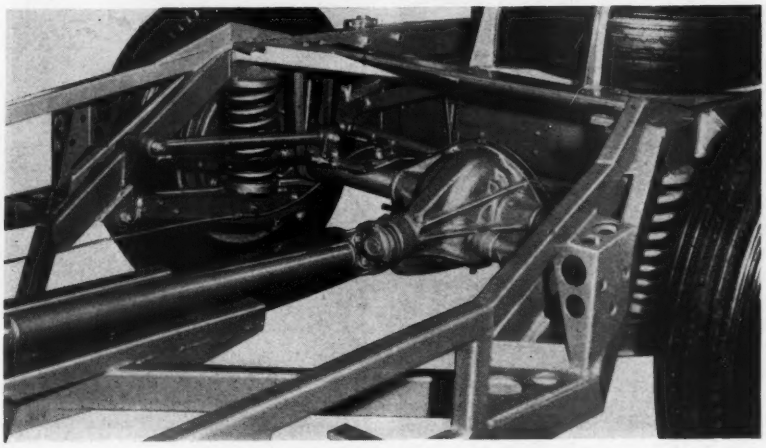
Silentbloc bushes are practically standard at the front ends of rear springs with Harris-type bushes in the rear shackles, but it was noted with approving interest that the new Austin Seven has bronze bushes at the upper ends of the shackles and rubber bushes in the spring eyes. Though this calls for a lubrication-point where most modern garage men would overlook it, it is a good feature in preventing lateral rolling of the shackles when cornering, improving the stability of the vehicle and probably increasing the life of the rear spring-eye rubber bushes.

Designers are beginning to realize the advantages to be obtained by offsetting the rear axle on its springs. Last year's Fiat models, it will be remembered, carried the principle to the limit by using half-leaf springs as anchorages with direct-acting coil springs to take the load.

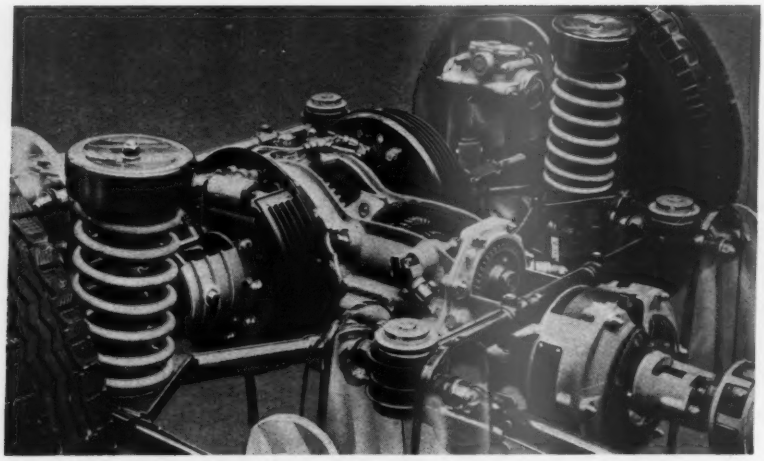
The principle can be more easily understood by taking the Fiat case as an example. In the absence of driving or braking torque the Fiat axle case will rotate as it rises and falls through angles corresponding to the length of the spring "radius rods". Any difference in the vertical movement of the two wheels is strongly resisted by the axle acting as an anti-rolling bar, the flexibility being in the leaf-spring arms instead of the very stiff "bar" formed by the axle casing.

Again, the torque-rod action of the leaf springs will turn the axle casing in such a direction as to reduce the rise and fall of the axle nose very considerably, enabling the height of the propeller shaft tunnel to be reduced. A more important result of the torque-rod action, however, is the downward force set up on the frame attachments when the brakes are applied, thus preventing rising of the rear of the vehicle when braking, or falling when accelerating.

While all this, is perhaps, is obvious to the experienced engineer, there may be some people who have not yet realized that all the effects mentioned earlier can be obtained, in a modified degree, by simply offsetting an ordinary axle on its conventional semi-elliptic springs. This is done, for example, on the new Vauxhall models, on which the axle is located only 19 inches from the front ends of the 48 inch rear springs.



Aston Martin parallel-link coil rear suspension



Independent suspension on Lancia Aurelia

The effect on the propeller-shaft universal joints will depend on their original setting, but it can generally be arranged that the angles, under spring deflections, are about the same at each end but in the same sense, instead of in opposition, as with a parallel motion of the axle. This will, of course make no difference in the overall instantaneous velocity ratio.

An interesting feature in the Vauxhall suspension is the use of rubber linings in the clamping of the rear springs to the axle. While hardly affecting the spring rate under direct load, these would be expected to modify the anti-rolling constants appreciably.

While the piston type shock absorber is still extensively used, especially as an integral part of the upper linkage of wishbone front suspension, the direct-acting damper is being increasingly employed both at front and rear. Detail improvements in both types include the change from disc valves to piston valves for control and, in the case of the direct-acting type, greater attention to the reduction of aeration of the fluid.

Particularly when mounted, as is now so common, in a diagonal position on the rear axle, the violent movements and accelerations, many times that of gravity, tend to break up the surface of the fluid in the reservoir tube. In the case of the diagonal mounting the action can almost be described as that of a cocktail shaker.

It is common to provide a baffle at an intermediate point in the reservoir tube, though this, if much loss of fluid occurs, may actually cause aeration if the level momentarily falls below the baffle. The new Girling damper has a coil spring embracing the pressure cylinder as a surge baffle. In other cases, a pressing is fitted in the reservoir tube with a suitable clearance between it and the outside of the pressure tube. Another possible cause of aeration may be the oil which leaks past the top bush and sprays or drops down through the diagonal holes in the top plug. Both Girling and Armstrong now fit return tubes extending down to the bottom of the reservoir.

Armstrong dampers now have, in addition, a circulating fluid system. There is no rebound valve in the working piston and the base valve does not permit downward flow. Both rebound fluid and piston-rod displacement fluid are discharged from the top of the pressure tube into a tube running down the reservoir space and having a spring-loaded rebound-control valve incorporated.

The fluid is thus continuously circulated and no reversal of flow takes place, conditions likely to favour the elimination of entrapped air. The fluid in the pressure cylinder is also likely to be cooler than would otherwise be the case. The only objection is the increase in the diameter of the reservoir tube to accommodate the rebound valve and correspondingly increased overall dimensions and cost, but the extra fluid capacity inevitably provided is a considerable advantage.

Newton dampers were shown with integral bump rubbers, which increase the length of the assembly but not its diameter, and also with rebound bumpers in addition. These necessarily increase the diameter of the cover tube, the rubber striking on an annular shoulder screwed into its open end.

Some dampers have provision for topping up by removal of a screwed plug. The damper made and used by Vauxhall Motors cannot be topped up but can be dismantled, while the Monroe absorbers are filled at the maker's works and sealed by welding.

Girling shock-absorber with leak drain from gland.

Newton telescopic shock-absorber with bump and rebound rubbers

Newton shock-absorber with rebound stop

BRAKES

Problems Intensified by Current Axle Load Ratios

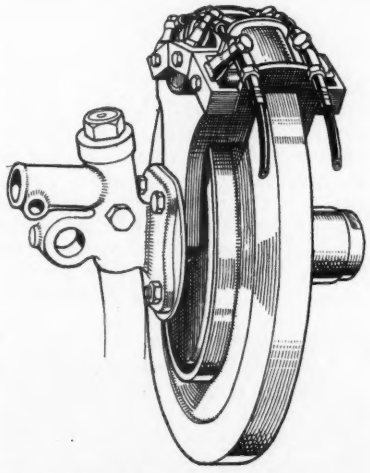
SINCE the Chrysler models exhibited at Earl's Court had internal-expanding, hydraulic brakes, there was no example present of the American disc brake. At present it is being fitted only to the largest Chrysler model. It is clear, however, that designers are seriously concerned with braking problems, these being increased in magnitude by the steadily increasing weight on the front wheels on the modern car. In the old days, a 60 : 40 brake drag ratio for front as against rear wheels, was held to be adequate for loads, together with the transference of load under severe braking. Nowadays, many cars run with a 60 : 40 axle load ratio quite apart from load transference, and it is clear that a standard set of 60 : 40 front and rear brakes will not give a proper balance of braking effort. Front brakes, in many instances, have to do about 75 per cent of the work when pulling up sharply from high speeds. As a consequence, drum expansion, drum distortion, temperature fade, and other troubles, are becoming more serious.

As far as temperature fade is concerned, the two-leading-shoe brake is inferior to a brake having a moderate servo action, and markedly inferior to the two-trailing-shoe Girling brake, as used on the new Jaguar cars. While variation in friction co-efficient has much less effect on the final result where there is no servo action, or even a negative servo effect, drum expansion becomes much more serious in terms of pedal travel on account of the high pedal-shoe ratios necessary. The Jaguar, with its two-trailing shoes, has recourse to a Clayton Dewandre vacuum servo. This is a reasonably compact unit, and gives an amplification of pedal effort of about 2 : 1. While this may seem to be a small figure, it should be observed that there is no vacuum reservoir on the Jaguar, so that power assistance is lost if the engine stops, and is not available when coasting with the engine at rest.

The Jaguar servo is entirely hydraulic in its incorporation in the chassis. The master cylinder, worked by the pedal, is connected to a plunger working the vacuum-control valve and to the hydraulic cylinder operated by the servo piston, which is in turn connected to the wheel cylinders. It may be conjectured that a more sensitive brake control would have been afforded had the "vacuum-suspended" system been employed, in which application of the servo action results from the admission of atmospheric air to the starting end of the cylinder, instead of exhaustion of air from the full volume of the other side. It is not inconceivable, however, that questions of patents are involved, and that may have decided the matter.

While a two-trailing-shoe brake gives a delightfully smooth action, it is far more sensitive to drum expansion under heat, on account of the very high pedal ratio that has to be employed. Hence a servo would seem to be essential on all but the smallest vehicles, in spite of the fact that the Hydrastatic principle always employed gives complete satisfaction, since there is no risk of the trailing shoes binding due to build-up of particles of brake material on the shoe tips.

Working under Dunlop patents, the Girling Co. is now doing development work on a disc brake. In this, a cast iron disc about ¾ in thick, is gripped between two or three pairs of circular pads of friction material fitted to the pistons of opposed cylinders. These cylinders are carried in a caliper member of box section, which em-



Girling experimental disc brake

braces the upper part of the brake disc. It is intended that the rest of the disc be left fully exposed, and it is claimed that direct cooling of the hot surface thus afforded gives much lower working temperatures. Disc distortion under load is negligible and expansion, also, can be disregarded as it refers to an original dimension of ¾ in only, instead of the usual twelve to fourteen inch diameter. This brake may be described as neutral, having no servo action in either direction. High pedal ratios can safely be employed, and the Hydrastatic principle is also used without any risk of binding. In one respect only is the brake to be criticized. When the friction facings are nearly worn away there will be about twice as much fluid in the clearance spaces behind the six pistons, as there would be in an ordinary two-leading-shoe brake. With a high pedal ratio, the brake would, in that condition, probably feel distinctly "spongy". Special attention will have to be devoted to the selection of the friction material, the working surface of which, though in duplicate, is very much smaller than that provided for the average internal-expanding mechanism.

If automatic transmissions of the American type ever became popular in this country, brake design is likely to be seriously affected. Owing to the absence of the clutch pedal it will be convenient, and customary, for drivers to restart from rest on a steep hill on the foot-brake. Under these conditions, a two-leading-shoe front brake system doing, say, 70 per cent of the work in a forward direction, combined with a floating-cam shoe at the back doing 30 per cent, will have an efficiency of less than half the normal in holding the car from running back on a hill. This factor would seem to make more desirable the use of brakes, such as the Girling disc, which are strictly neutral, that is, exercise exactly the same power in either direction. In the past, the car has been held by the hand brake on the rear wheels for re-starting on a hill, and the relative uselessness of a two-leading-shoe front brake in the rearward direction did not become apparent. The type of disc brake mentioned has undergone a good deal of development work in America, and would seem to have distinct possibilities. It may be practicable, on account of the simple nature of the castings and machining, to use discs of chilled iron which is less susceptible to wear than ordinary material.

The Lockheed Co. exhibited their standard range of brakes with no notable modifications, though an interesting exception is a brake with automatic adjustment designed for racing cars. This takes the form of a strut between the two shoes having ratchet teeth engaged by pressed steel pawls having a limited amount of end play on the pin which secures them to the web of one brake shoe. The design would hardly be acceptable on the average private car, since more than normal clearance must be provided, failing which the adjustment might take up the clearance of a hot brake to such an extent that it binds when it cools off.

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Pull-up handbrake on Hillman Minx

Lockheed brakes on the new Austin Seven are of considerable interest, if only for the fact that they have been designed throughout for the particular vehicle and represent, therefore, a complete departure from the policy of standardization previously followed by the firm. The brake drums are 7 in diameter and 1¼ in wide, those in front being of the two-leading-shoe type. Adjustment is by a toothed wheel, locked by a spring clip, that rotates the piston on the screwed tappet. Access is obtained through holes in the wheel and brake drum. Thoughtful attention to detail is revealed by the chromium plating of the toothed disc while the shoes and other mechanism are painted black. The bright adjusting disc can thus be easily seen through the hole.

Following a practice widely used in Lockheed hydraulic control mechanisms, the pistons in the wheel cylinders have rectangular grooves in which synthetic rubber sealing rings are inserted, these being made with a bias which throws the trailing edge against the cylinder wall so as to give the action of a cup leather. A great advantage in this system is that the piston has a solid end which cannot be damaged and requires no separate filling piece to reduce clearance space.

The master cylinder with its integral oil-box is bolted up directly under the toe-board, with the interposition of an inverted U-section pressing. The forwardly extending lugs of the pressing take the fulcrum pin for the brake pedal, a depending arm on which thrusts rearwardly on the master piston. Replenishment is by unscrewing an accessible plug in the toe-board.

The operation of the rear brakes is quite original, oil being taken to a ⅝ in diameter cylinder fastened to the chassis frame. The piston thrusts forward the front end of a stirrup-shaped pressing, while the other end is attached to a rod supported by swinging links and carrying on to a swivel-tree on the back axle. From the swivel tree two cross-rods actuate the mechanical rear-wheel brakes. The hand-brake rod pulls on to the front end of the stirrup, and operates through the same mechanism. The two rear shoes are operated by bell-cranks enclosed in boxes free to slide fore-and-aft between jaws on the back plates. A short push-rod on the end of the bell crank operates as a tappet bearing on one shoe, while the other shoe is thrust out by the reaction of the sliding box in which the bell-crank is housed. Any rattling of the various parts is prevented by a clip fitted over the top take-off spring which pulls it inwards a considerable distance, keeping the shoe tips hard against the tappet and the adjusting screw on the box, which in its turn is held firmly against the back plate. A great deal of care has been taken in proportioning the size of the cylinders and the leverages, to get exactly the right distribution of braking under normal operating conditions. Some compromise has, of course, to be effected in the case of a car such as the Austin Seven, which weighs only about 13½ cwts and suffers a considerable increase in rear axle load when the back seats are occupied and luggage is carried as well.

In common with all Lockheed brakes, the Austin Seven shoes are of the sliding type and the faces of the abutments are parallel. This naturally involves bringing the lining as close to the heel of the shoe as possible. In the case of the rear brakes, the web of the leading shoe is deeply notched somewhat on the toe side of centre, while the trailing shoe is similarly notched closer to the heel. These modifications have been found to reduce brake squeak considerably.

On the new Vauxhall chassis it is of interest to observe the two-leading-shoe brakes are not used in front. Instead, the shoes are leading and trailing as in the rear brakes, with the leading shoes connected to the fulcrum by inclined links on the Huck system, which ensures a better bedding of the lining right from the start and greater consistency of operation. Vauxhall design and make their own brake shoes and operate them by Lockheed equipment and have therefore left themselves free to use 1½ in wide shoes at the front as compared with 1¼ in at the rear, so as to equalize lining wear. The brake drums, of Lepaz pearlitic iron, are 9⅛ in diam. and are machined with the races of the taper roller bearings as location. These being an interference fit, the tolerance in the hub bore does not affect the concentricity of the fitting of the part to its spigot, which has a taper seating.

Hand-brake lever with plunger guard on Vauxhall Velox

There seem to be two alternative methods of balancing brake drums. One consists in casting three fairly large segmental pads and drilling these as required to get balance. The alternative, and generally preferred method, is to select suitable washers after balancing and drill the web of the drum and rivet them on. In our opinion the latter arrangement is much the better. The balancing pads, from their shape, are likely to be rather unsound and porous. They might well call for considerable drilling to balance the drum which, cast without them would have been true enough to require no balance adjustment at all. Again, the amount of metal that can actually be removed if the drillings are not to break into one another, is quite a small proportion of the total added mass. The finished weight of a balanced drum made on these lines is likely to be considerably greater than that of the drum made by adding washers, especially when one considers that a good many drums will very likely pass the balance test without any addition at all.

American standard practice in brakes still appears to favour the duo-servo, hydraulic brake, which for cars having hydraulic transmissions and liable therefore to be restarted on the foot brake, has the great advantage of being equally powerful in both directions.

Many of the Continental cars being produced on a relatively small scale have aluminium alloy brake shoes in place of the pressed steel shoes which are almost standard on both English and American products. As at the last Show, there were some transmission hand brakes to be found on Continental cars, such as the Fiat.

The use of aluminium alloy drums with iron linings is extending somewhat, especially on the higher class

sporting vehicles. On the Allard, for instance, the brake drums are the Al Fin type in which the drum body is intimately cast on to the iron lining, ensuring a good transference of heat from one metal to another.

Facility in fitting still favours the flexible cable and pistol-grip hand brake, which has otherwise little to recommend it. However, it was observed that one or two new models had pull-up brake levers alongside the driver's seat. A rather interesting one was on the new Vauxhall, in which a circular eye protects the release thumb-button from accidental depression by the driver's foot when getting in or out of the car.

Liners bonded to the steel shoes are practically standard in America, nearly standard on Girling products and available on demand in the case of Lockheed brakes. Shoes are, of course, 100 per cent tested by applying a severe lateral load to the lining to prove the bond before issuing to the assembly line. The general practice is that the pad of the testing press makes a couple of marks on the edge of the metal shoe which indicate that it has been tested. It is a most desirable method, as the complete failure of a bond could have very serious consequences.

FRAMES

Few New Frames. Wider Adoption of Unitary Construction

MODERN welded steel body-work is already so stiff and strong that the duty to be expected of a separate frame that carries it is not easy to assess. Whatever the explanation, the fact remains that there is more variety in frame design and construction than in any part of the vehicle. Consider, for example, the contrast with the frame of the Austin A40—comprising two side-members, a fairly light but far-reaching cross-bracing completed by one cross-member at each end—that is afforded by the Rover frame—with box-section side-members, no cross-bracing, but no less than five cross-members, all of large box-section.

Compare either of these with the interesting Lagonda frame, which can almost be described as a cross-bracing with a few trimmings. The inescapable logic of the design lies in the fact that there are occasions, especially in the life of an independently-sprung car with its spring-base equal to wheel track, on which the whole vehicle is momentarily suspended by opposite corners.

In resisting the stresses set by such a condition, the ordinary side-member makes practically no contribution, except as part of a torsionally stiff raft built up of tubes along and across in Rover fashion. If the cross-bracing is really stiff the whole load will be carried momentarily by one complete diagonal, and a structure capable of standing this can easily take care of the halved stresses resulting from the sharing of the bending moments by both diagonals when the wheel-loads are equally distributed.

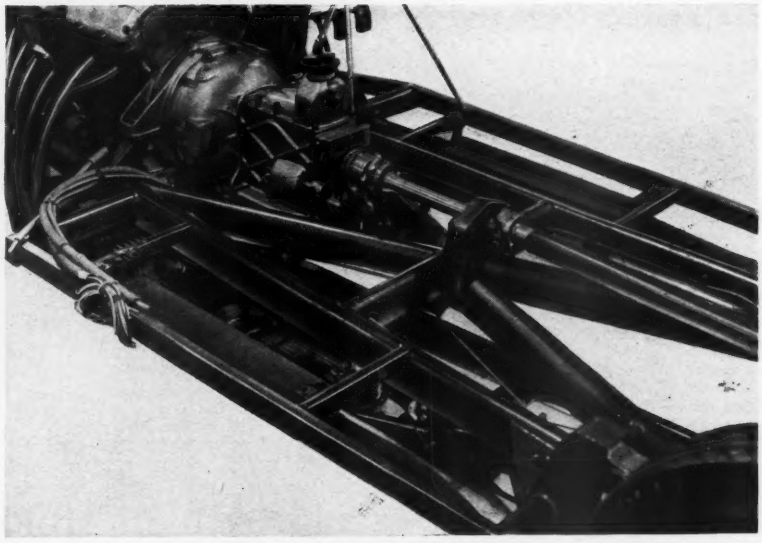
It is, of course, necessary to tie the ends together and provide rudimentary side rails, supported by outriggers from the crossing-point of the bracing, to give intermediate support to the body and take care of lateral bending-moments by triangulating the bracing system, but the basic idea is sound. The real limit to its general application is nowadays set by the insistence on floor-lines so low that really deep cross-bracing is not possible.

With increasing popularity of the integral chassis and body the new frames were few, and they were used on high-grade cars of special appeal and limited output. The Aston-Martin chassis is built of rectangular tubing of two sizes only, one square and the other of the same width but deeper in section. The side rails are of built-up girder form, with vertical tubular spacers. At the rear kick-up they converge, being given additional lateral stiffness by inner members running down to intermediate points on the tubular cross-bracing.

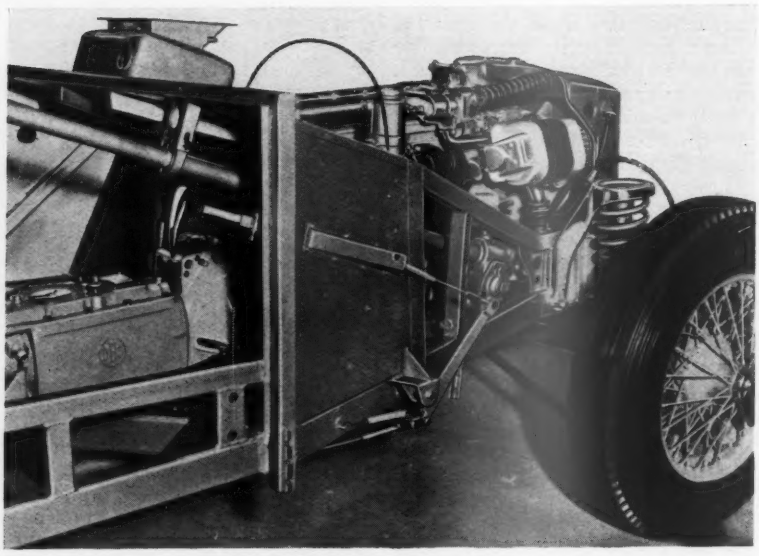
At the front, the upper and lower members of the side rails converge but receive great stiffening from the flat-sided steel scuttle, which is framed with small square tubing and has its upper front corners braced by diagonal tubes to the side-rails in the region of the attachment point of the I.F.S. coil spring brackets. The design is very complicated and the cross-bracing, which lies entirely below the propeller shaft, is quite shallow. But taken as a whole the frame appears to be fairly stiff in torsion as a result of the contribution made by the scuttle and the fact that practically every piece is a tube of fairly heavy gauge.

The underslung chassis of the Ferrari Type 212 is mainly built up of oval tubing of one size, forming the side rails, the diagonal bracing—passing under the propeller shaft—and a central cross-tube joining the crossing-point to the side rails. In front of the engine comes an elaborate welded tubular cross-member with brackets welded to it in various positions to take the details of the wishbone I.F.S. including a leaf spring passing underneath the member.

At the rear, the side rails are spanned by a circular tube coming just under the nose of the axle, this tube merging into the rear ends of the diagonal cross-bracing, the junction being reinforced by a plate bracket which takes the vane-type, rear shock absorbers. The front ends of the twin rear leaf springs pass into open-ended boxes welded to outriggers stiffened by short distance-tubes joining the side rails to the diagonals; the outriggers also supporting the rear ends of light channel rails taking the bodywork.



Tubular cross-braced frame of Ferrari 212 chassis



Scuttle and front of frame on Aston Martin chassis

Following the firm's customary practice, the frame of the new Diamler Regency chassis has pressed, box-section, side members, inswept for front lock clearance and to take the radius arm of the Girling suspension. The inswept part is reinforced by an inserted channel pressing running back to join the massive channel-section cross-bracing. This inserted channel carries on forward to where the side member curves away from it again to leave a space for the coil spring of the front suspension, the two being finally reunited in the region of the large tubular front cross-member.

Intermediate between the two types of construction, the Triumph Mayflower has a separate chassis, but incorporates with it the toe-plate, main floor pressing and rear-wheel arches as valuable stiffening members. From the front, back to the rear kick-up, the side members are of inverted top-hat section, sharply curved in plan and converted to box section by cover strips in the engine compartment and by the floor sheet behind this point. At the kick-up the side members are continued by top-hat pressings arranged with the flanges outwards and welded to the wheel arches and to continuation plates. Except for the floor pressing there are only two cross-members, a 3 in $\times$ 2 in box-section front member and an inverted top-hat section member supporting the rear of the power unit and braced by two diagonal corner stays.

In the increasing number of vehicles having integral body and chassis there is a general tendency to dispense with relatively heavy-gauge local reinforcement by sub-frames, rudimentary side rails and the like, and rely instead on careful design of the main 20 gauge pressings, supplemented by 18- or 16-gauge doubling plates at attachment points.

The new Austin, which is the firm's first example of unitary construction, well illustrates this point. Partly because it is a small car—about 13½ cwt kerb weight, with small wheels—stresses are less than the average and the 20-gauge steel sheet, the standard body material of the industry, is adequate without extensive reinforcement.

The new Vauxhall models, built by a firm that was one of the pioneers of unitary construction, get the main strength of the front portion from diagonal pressings running down from the corners of the scuttle and stiffened by incorporation of the front wing valances. These pressings are welded to box-section rails running back to the toe-plate and to these the I.F.S. front cross-member is attached by rubber mounting-washers.

At the rear, similar diagonal pressings run from the rear seat squab plate down to the spring attachment points. The body sills blend into boxed sections at the scuttle corners and over the front of the rear wheel arches. The structure derives much of its strength from the roof, the rear quarter of which blends into the triangulated back portion.

The partial enclosure of the engine compartment by the front diagonal pressings is carried much further on the Ford Consul and Zephyr cars, in which the outwardly flanged front valances run horizontally to join a cross-bulkhead, pierced to take the radiator and forming, in conjunction with the scuttle, an open-topped rectangular box. Owing to the special design of the front suspension system, with its attachment points spaced some 30 in above one another, local loads are so small that reinforcement of the flanged lower edges of this box by additional box outriggers is not required, the two light cross members being attached direct to the main pressings.

In spite of the wide use of the expression "stressed-skin" in sales literature, the designer is only too well aware that large parts of the skin of a car cannot contribute to its strength. Quite apart from the doors, the wings, front and rear covers etc do nothing to help and are troublesome to fit. Vauxhall unite the two front wings in one unit with the front grille frame, making a stiff assembly, to which the bonnet cover can be accurately fitted before the whole is secured to the body structure.

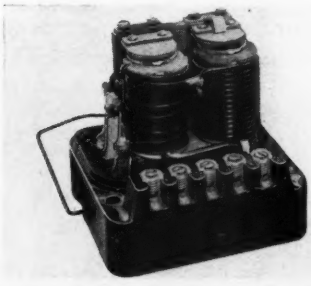
Aston Martin tubular chassis

ELECTRICAL EQUIPMENT

Progressive Standardization of British Components. Heater Installations Improved

INDIVIDUAL units of the electrical equipment have not undergone any drastic alteration in design since the last Show, though many modifications have been made as the result of experience with the object of maintaining performance over a longer period without attention. That is a question of durability, as distinct from ultimate reliability. Simplification of design has been effected in many instances, which facilitates manufacture. Certain materials such as zinc, nickel, and lead, to mention only three, are becoming more difficult to obtain, and the possibility of employing substitutes continues to receive considerable attention. The average life of a battery, even now when voltage control is universal, probably does not exceed three years so that this unit alone continues to require considerable quantities of lead. In view of the present high price and very definite shortage of this metal it is surprising that such small value is attached to worn-out batteries, and also that so little progress has been made in the commercial utilization of a different material.

Standardization of units has been carried a stage further. The requirements of British cars, for instance, are satisfied by two sizes of dynamos, three starters, and only one control



Lucas control box type RB 106-1

box, though in this case one of the windings in the regulator has to be changed to suit the maximum output of which of the two dynamos it controls.

In the case of American cars, including most of those of Canadian manufacture, the requirements cover a wider range, but this is more than balanced by the enormously greater output. The car manufacturers' requirements' are fulfilled by two makers of components, and in the majority of cases their complete units are interchangeable so that two sources of supply are available if required.

All the American and Canadian cars shown, and also the two small British Ford cars, the Anglia and the Prefect, are fitted with 6-volt systems. The American and Canadian models, owing to the larger dynamo output at the low voltage, employ current control in addition to voltage control. In the case of the two small Ford cars the usual compensated voltage control is adequate.

All British cars, including the new Ford Consul and Zephyr, use the 12-volt system with compensated voltage control, and even the new Austin Seven is similarly equipped.

Amongst the Continental makers, the 12-volt system is also universal and, with the exception of the Delage, the dynamos are all shunt-wound and have voltage control. The Delage uses a third brush constant current machine, and a 75 ampere hour battery. The Delahaye has a normal S.E.V. equipment and even the small cars, such as the Panhard Dyna, the Renault, the Fiat 500 and the Simca, use the 12-volt system.

The twelve-cylinder Ferrari has a particularly interesting and compact equipment. A separate ignition head complete with centrifugal mechanism is coupled directly to the front end of each camshaft and supplies its own bank of six cylinders. In the space between these two heads, and immediately behind the radiator, is installed a gear-driven 12-volt Marelli dynamo.

The ignition heads are also of Marelli manufacture and appeared comparable in size to that fitted to the 500 Fiat engine, though that is a four-cylinder unit.

Dynamos

Practically all dynamos are now ventilated, the fan being located immediately behind and integral with the driving pulley. Air is drawn in from the opposite end, passing first over the commutator and then through the machine to the fan. In British cars the Lucas 3·9 in and the 4·5 in diameter models cover the requirements as the larger fans now fitted make possible a maximum output of 19 and 22 amperes for the two machines respectively. As the machines are voltage-controlled they are rarely required to give this output, though it is available, and could only be required or used with a full load and a completely discharged battery. Even under such abnormal conditions the machines are well up to their work.

Dynamos fitted to American and Canadian cars are also ventilated by a fan at the driving end, which exhausts the air which has passed through the machine. They are, of course, all 6-volt machines and have been standardized by Delco-Remy and Autolite in five sizes, having outputs of 30, 35, 40, 45, and 50 amperes.

From a cursory examination the 35-, 40-, and 50-ampere generators appear to be the most generally used. For instance, the Kaiser models are equipped with a 35-ampere Delco-Remy or Autolite generator. Those at the Show happened to be Autolite.

The Dodge has four types and sizes of dynamos which can be fitted. In this case, they are all of Autolite manufacture, two having outputs of 45 amperes and two of 50 amperes.

The General Motors group is, of course, fitted with Delco-Remy machines, and out of the Chrysler group some are fitted with Delco-Remy and some with Autolite, so that evidently all the machines are interchangeable, both as regards outside dimensions and electrical characteristics.

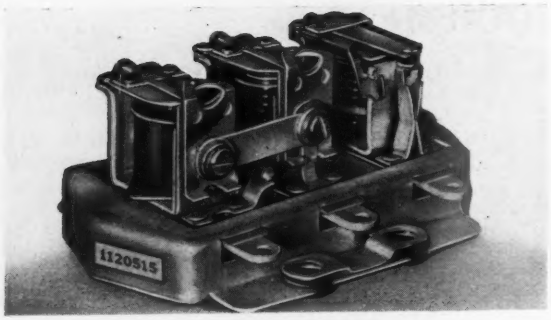
Control boxes

The Lucas combined cut-out and compensated voltage control box No. RB 106-1 shown is suitable for all British cars and light commercial

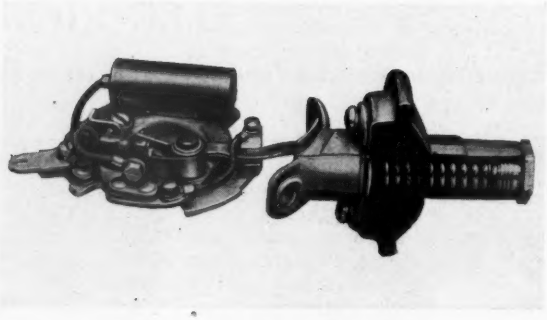
Delco-Remy two-unit control box

vehicles fitted with the 3·9 in or the 4·5 in dynamos. It has a single contact regulator giving automatic regulation of output according to the state of charge of the battery and the current required by the various electrical devices in use.

Slightly different series compensating coils are required in the two cases to suit the maximum output of the particular generator to be controlled, but otherwise the units are identical. As the generator output and load rise the number of series turns required in the compensating coil



Autolite current and voltage control box



Autolite vacuum advance mechanism

falls. The sensitivity of the regulator to changes in load becomes less with a reduced number of series turns and, although it is still sufficient with the maximum current at 12 volts required by a private car, there is not very much in hand and this margin is being continually reduced as the load on the electrical system grows.

With the 6-volt system, of course, as used in America, the current for the same power is doubled. In the larger private cars, at any rate, the load at which the system can satisfactorily operate has been passed, as it has in this country in the case of the larger passenger vehicles, even with the 12- and 24-volt systems in use. In consequence, an additional complete regulator unit has to be added to the control box, having a series winding only and thus operated only by the current passing through its winding. The Autolite regulator box shown, is a typical example of the three-unit box fitted to the larger American cars, and the Delco-Remy control box shown is typical of the two-unit box fitted to the smaller vehicles. The two firms referred to, of course, each make both types of box.

Coil ignition equipment

Two new coil ignition distributors are being shown by the Lucas Co., the D.M. and the D.M. 2 models. The first is available for either four- or six-cylinder engines and the second only in four-cylinder form, to which it is restricted by its smaller diameter. In the D.M. distributor, the main drive shaft of hardened steel runs in a cast iron shank forming the lower part of the body of the unit. Lubrication is by oil mist from the crank case, supplemented by an external greaser at the upper end of the shaft.

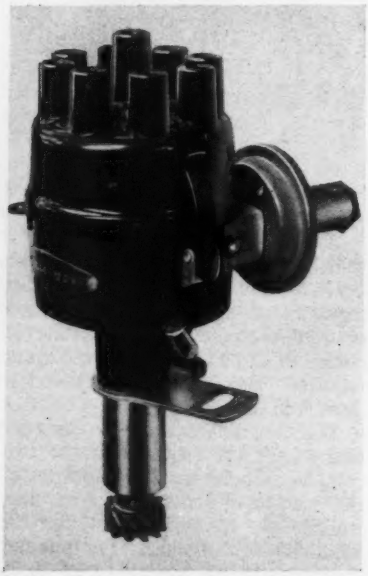
The hardened steel shaft of the D.M. 2 distributor runs in a long, oil-impregnated bearing bush. By the use of these long bearing surfaces any side play in the shaft, and consequently in the contact-breaker cam is minimized and the accuracy of ignition timing is always maintained within close limits. In addition, these new distributors are very silent in operation.

Each type of distributor has built-in, vacuum-operated timing control in addition to the usual centrifugally operated mechanism. The vacuum control is of a new and improved design and is linked to the contact breaker base plate, designed to move on a special bearing assembly about the driving shaft, so advancing and retarding the point of ignition in relation to the engine load. A centrifugally operated mechanism of improved pattern is housed in the base of the distributor.

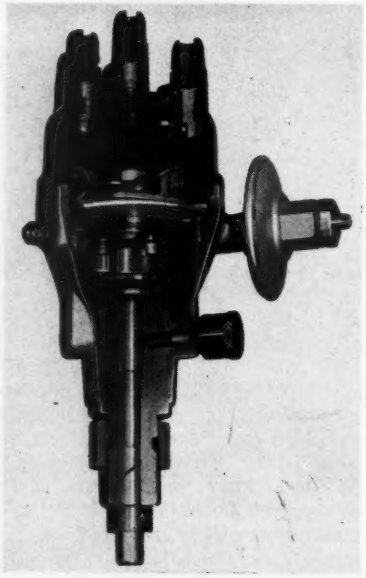
Special attention has been paid to sealing the unit against the entry of dust, and the new metalized, self-sealing paper condenser is fitted to all models in this range. The plug leads enter the distributor at the top in an axial direction, though if the space above is limited a different cover can be substituted in which the leads enter from the side. These two distributors cover the requirements of the majority of British cars.

The general appearance of the distributors fitted to American cars, is shown in the illustration of the Autolite model used in the Hudson. In this case, also, the centrifugal-advance mechanism operates the contact-breaker camshaft in the usual way, and the vacuum advance, the mechanism of which is shown separately, operates by partially rotating the contact-breaker base plate. The angular advance is only a few degrees and is limited by stops at each end of its travel. The strength of the spring controlling the diaphragm can be altered by varying the number of washers behind the spring. This is not an adjustment, but is the method of setting, and is carried out at the factory before delivery.

The Loadomatic system of ignition advance fitted to the Canadian-built Ford was described in the last Show report, and this year the use of the system has been extended to both the Mercury and the Lincoln. In the Lincoln distributor illustrated, the method of applying and adjusting the return



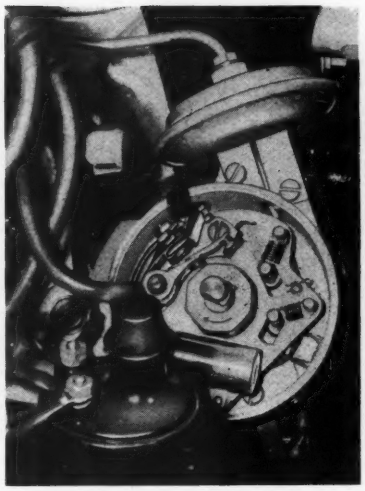
Autolite distributor fitted to Hudson



Lucas D.M. type distributor

springs controlling the contact-breaker base plate is shown. The angular position of the plate is controlled by the carburettor through a vacuum diaphragm and rod linkage in the usual way, though no centrifugal weights are used.

The springs referred to are two in number and tend to return the plate to its retarded position. The first part of the advance extends the lighter spring, the heavier one coming into operation a little later. Each spring is anchored to a pin mounted eccentrically on a larger pin, the rotation of this furnishing the adjustment of tension. By altering the tension of the two springs, the shape of the advance curve can be modified slightly if necessary. The angle of advance at any instant is determined by the degree of vacuum at the diaphragm. This is produced jointly by the depression at the throat of the carburettor, and thus is a function of speed, and the depression at the throttle which, being related to that of the manifold, is a function of the load. Consequently, the angle of advance is governed by both load and speed, as in the case of the usual combined centrifugal and vacuum system. The method of combining the two effects produced at the carburettor has been described previously. This system brings with it the advantage of the ignition camshaft being in one piece, so that its bearings can be more widely spaced, giving greater accuracy to the timing.



Carburettor-operated advance mechanism on Lincoln

Starting motors

The standard Lucas machines are three in number, and their range is sufficient to cover the requirements of nearly all British cars. They have yoke diameters of $3\frac{1}{2}$ in, $4\frac{1}{8}$ in, and $4\frac{1}{2}$ in respectively and operate through one or other of four standard drives, the S, SB, Eclipse and rubber type. The most generally used are the S and SB patterns which are of the standard inertia type, the shock of engagement being taken by a spring in the usual way. In the SB type the pinion rides directly on the motor shaft and can in consequence be made smaller to provide a higher gear ratio between the starter and engine.

The rubber drive is used in many applications, such as the Rover 75. The design is somewhat complicated and has been fully described in a previous Show report. It consists essentially of a rubber torsion member combined with a friction clutch; the rubber taking up the shock of engagement and the friction clutch acting as an overload-release mechanism. This operates in the event of extreme stress, such as a heavy reverse kick, or in the event of the pinion being forced into engagement with the flywheel momentarily rotating in the reverse direction. The chief merit of the design is that it is more silent in operation than the others, due to the damping effect of the rubber. Starting switches are generally relay-operated, as this makes it possible to use a shorter heavy cable.

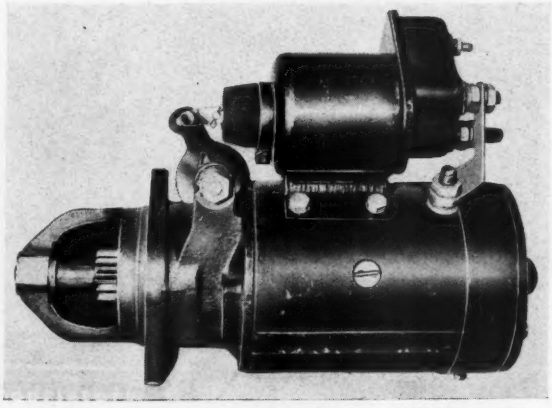
The system in which the pinion is brought into engagement before the full power is applied to the motor is widely used in the larger American cars such as Buick, Cadillac and Packard, though in this country its use is confined to very few special applications outside the commercial vehicle field. A typical unit is the Autolite model shown, in which the relay switch is mounted at the back of the solenoid which moves the pinion along the motor shaft into engagement. Full voltage is applied to the starter only when the solenoid mechanism has moved to the end of the panel, the pinion then fully engaged. The last part of the motion closes the main switch. In some cases the solenoid mechanism is omitted and the engagement effected by direct mechanical action.

Batteries

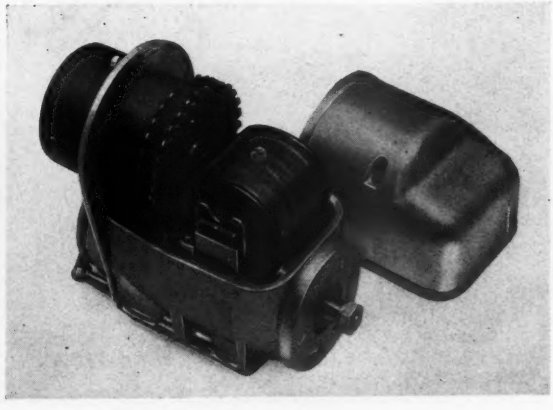
The Lucas G.T.W. range of semi-linkless batteries arranged for girdle fixing is now standard equipment on most British cars. This method of holding the battery has proved more satisfactory than the previous method by fixing lugs and bolts as it prevents damage to the casing through excessive tightening of the bolts. Battery terminal corrosion has been made negligible by the introduction of a new cable connector in which a lead terminal, die-cast directly on the battery cable, is secured to the battery terminal post by means of a lead-plated self-tapping screw.

For export purposes, Lucas batteries are supplied dry-charged and sealed before leaving the factory, so that there is no deterioration during the storage period and it is only necessary to fill each cell with acid of the correct density when the battery is required for service. When supplied in the dry-charged condition porous rubber instead of wood is used for the separators.

Dagenite "Dual-life" batteries were



Autolite starter motor with solenoid engagement



New Scintilla six-cylinder magneto

shown by Messrs. Peto and Radford for the first time since the war. The negative plates in these batteries are enclosed in envelopes of a tough micro-porous plastic material which, it is claimed, entirely obviates the risk of internal short circuits. These envelopes, completely resistant to oxidation and acid attack, are so highly porous that the electrolyte can diffuse through them freely and the maximum performance is obtainable from the battery at all rates of discharge, even at the high rates needed for engine starting.

The Chloride Co. showed a wide range of Exide batteries of standard design, and also their "Double Life" model which has, in addition to the usual treated wood separators between each pair of positive and negative plates, a specially impregnated sheet of finely felted glass wool completely enclosing the positive plates. This design has been more fully described in a previous report.

The Young Accumulator Company also exhibited their armoured batteries, in which each positive plate has on both sides a sheet of glass silk, a sheet of perforated ebonite and a sheet of porous ebonite, which has been developed by the Company and is known as Porbonite. The ebonite sheets are vulcanized together, forming an envelope round the positive plate. This system has been fully described before. These are only three examples of the many makes exhibited.

Windscreen wipers

Practically all British cars built since the war are equipped with the Lucas cable-rack wiper model C.R., in which a motor and gearbox unit mounted under the bonnet on the engine bulkhead transmits motion to the two wiper arms through a flexible cable and rack mechanism. A recent

Lucas type D.R.1. screen wiper motor and drive

modification to this type of wiper motor takes the form of a protective device consisting of a thermostatically controlled circuit breaker which cuts off the current if the motor becomes too hot, due to the blades being prevented from operating by ice and snow. Normal working will be resumed when the motor has cooled down and the obstruction removed.

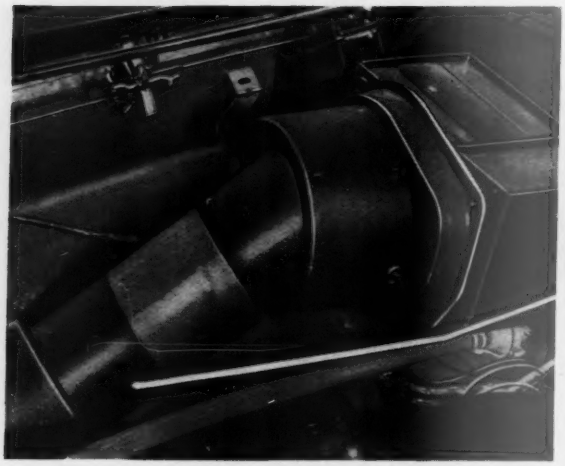
A new windscreen wiper, model D.R.1. retains the principle of cable-rack drive but the motor is larger and more powerful, making it particularly suitable for use on large curved windscreens. A single-stage reduction gear incorporated in the motor operates a robust cable-rack mechanism. The wiper blades are provided with internally splined headpieces which mate with corresponding splines on the arm spindles. The wiper control switch has three positions, High-speed, Normal, and Park. High-speed working is intended for conditions of very heavy rain and is obtained by the insertion of a resistance in the field circuit of the motor. When the control switch is turned to the Park position, the motor is reversed and an eccentric on the final drive gear then drives the cable crosshead past the normal operating point and brings into action an additional switch housed in the motor gearbox. The position of this switch is such that when it cuts off the current the blades are correctly parked and off the screen. The motor is also protected against overloads by a thermostatically controlled circuit breaker. The motor and gear are almost inaudible in operation.

Trico-Folberth exhibited a new electric screen wiper which can be supplied with the control switch either mounted on the unit or separate as required. It is designed for single hole fixing either at the top or bottom of the windscreen, with a range of shaft lengths suitable for most screen frames. The unit is quite small in dimensions and suitable in shape for mounting on all normal screens. The speed of wiping is well above the average and the motor, surprisingly powerful for its size, operates with the minimum of noise.

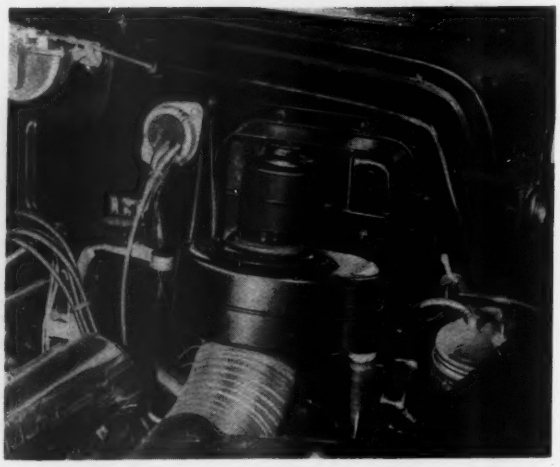
The suction wiper is still a standard fitting on many American cars and operates with the assistance of the A.C. combined fuel and vacuum pump, described in a previous report. The electric two-speed type with automatic parking, however, was fitted to all the larger cars at the Show, such as Cadillac, Packard, Buick and others.

Magnetos

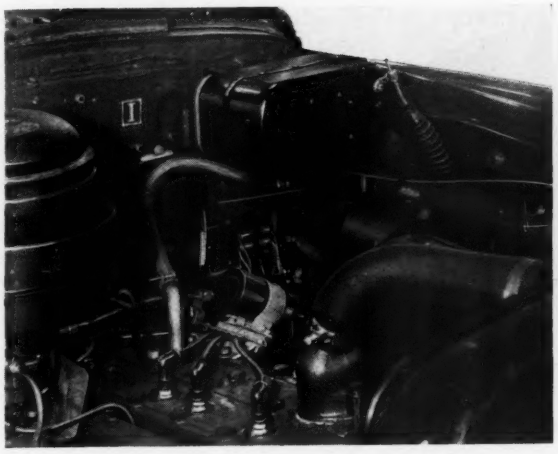
A full range of machines of both the vertical and horizontal type was shown by British Thomson-Houston, Lucas, Scintilla and Wico-Pacy, and have been described previously. A new Scintilla six-cylinder model is, however, of interest. It is a horizontal, two-pole, rotating-magnet type with the usual Scintilla contact breaker giving two sparks per revolution. The breaker is attached to the end of the driving shaft which carries the



Smith heater unit on Vauxhall Velox



Defroster and ventilating unit on Cadillac



Heater unit and blower on Pontiac six-cylinder

Heater unit and blower on De Soto

magnet. Die-cast in light alloy, the frame has cast into it on each side the laminated core plates which form the magnet pole-pieces at their lower end. The upper ends of these cores are faced to receive the laminated core pieces carrying the primary and secondary windings which are in the form of a single coil. A distributor is mounted in front of the machine and carries the six plug-lead connectors.

The rotating part of the distributor carries a wheel which is driven from the main armature shaft with a ratio of 3 : 1. The drive, however, is by a rubber V-belt of peculiar form. The inner surface of the belt is serrated to form teeth which engage with a toothed steel wheel integral with the driving shaft. The distributor wheel has slots on each side of its groove to engage with projections formed on the side of the belt. The driving wheel is wider than the belt, so that the belt is free to take up the lateral position dictated by the distributor wheel. The drive is as short as it is possible to make it, the wheels only having a small clearance with each other.

A cast aluminium cover encloses the winding and the body of the machine, including the back of the distributor. The lightness and compactness of the machine is surprising, particularly in view of the power of the spark produced. The fact that the distributor is belt-driven does not, of course, affect the accuracy of timing which is controlled by the contact breaker. Any variation in the position of the distributor is negligible compared with the angle of advance or retard. Needless to say, the machine is practically noiseless in operation.

Two small magnetos and also a distributor head designed for bolting directly to small stationary or agricultural machines were also shown, and have been described previously. In these the operating cam is attached to the engine shaft which drives the units and the machine lies flat against the face of the crankcase.

The Wico-Pacy Co. exhibited three small flywheel magnetos, the magnets being cast in the flywheel rim. The smallest was designed for the J.A.P. 34 c.c. engine. The windings are stationary in all these machines, the contact points being operated by a cam on the engine shaft.

Heating and ventilation

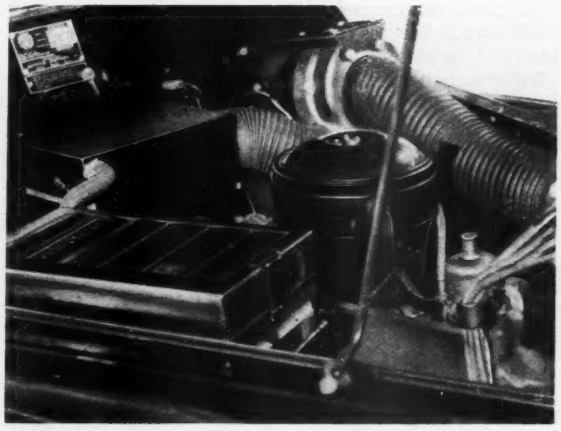
More attention has been given to the installation of these units. With few exceptions, it is only on the larger or more expensive cars that the equipment is included in the purchase price. The suggestion that the fitting of these units was an after-thought was provoked in the case of certain cars made in this country.

The majority of the smaller British cars fit the circulating type, as it is small, compact, and easy to install. Even when supplied without heaters, the cars have slots provided below the windscreen for de-misting and de-frosting, so that the subsequent fitting of the heater is simplified. The chief disadvantage of this system is that the heater is usually mounted on the passenger side of the bulkhead, and unless some provision is made for distributing the heat, very little reaches the rear seats ; also, if ventilation is to be obtained by opening a window, the cold air becomes a draught.

Though the heater of the Hudson is mounted on the passenger side of the bulkhead, arrangements are made to distribute the heat. Further, provision is also made for admitting fresh air to the heater to supplement the circulating air, to any desired proportion or even exclusively.

The larger cars draw their air from outside and pass it though the heater unit or not, as required, so providing ventilation to the body. Large ducts take air from the front part of the car, usually in front of the radiator and deliver it to the unit, which is generally installed on the engine side of the bulkhead. Large American cars, such as Cadillac, Buick, and Packard, have two ducts, one on each side, within the bonnet, and even some of the smaller ones, De Soto and Kaiser are examples, are equipped in the same way.

Some of the Smith installations, the Rover 75 is an instance, also have the two ducts. In all cases only one duct delivers air to the heater, the other supplying cold air only. In some of the luxury models there is now a tendency to separate the body heating from de-frosting, and allow the air



Smith heater unit and blower on Morris six-cylinder

from the screen slots to produce the body ventilation. In the case of the Smith installation on the Rolls-Royce and Bentley, the system consists of a flat, circular heater below the front passenger seat, which circulates air within the body and passes it out in front to the driver's compartment and backwards to the rear passengers. The degree of heat from the circulating unit is regulated by varying the fan speed. The screen slots are fed by air taken from the blower low down in front of the radiator and delivered to a separate heater on the engine side of the bulkhead.

The Buick and Cadillac have a very similar system, but in addition they supply air to ducts below the large rear windows, which are now fitted to American cars. In this case, however, the air is heated by passing through a small electric heater, which takes its current from the battery system. Two large ducts from the front of the engine are standard and are controlled separately.

The Smith system employs a single unit for producing and distributing the heat to the body, and also for supplying the screen slots. In some of the smaller American cars, such as the DeSoto 6-cylinder, a single Mopar Model 101 heater unit is fitted and air to the body is directed downwards below the facia on each side, so that after warming the front passengers, it passes under the front seats to the rear compartment.

A somewhat similar system is used on the Mercury, Lincoln, Pontiac, and Kaiser, amongst others. Kaiser models shown had no heaters fitted, but the ducts and other fittings were there, the controls being left blank.

Heat control is usually effected by varying the speed of the blower motor, and also by diverting the incoming air from the heater. In hot weather, when ventilation is of more importance than heating, the water to the heater can be shut off, but in no instance except the Vauxhall Velox is the flow of water used to control the temperature. Thermostatic control of incoming air is sometimes fitted, as in case of the Buick. Here a thermostatic valve either allows the air to pass through or by-pass the heater to any required proportion as determined by the setting of the thermostat from the dash-board. This control of the thermostat is by a lever working in a lateral slot below the facia board, its function being to vary the strength of the spring which balances the thermostat.

The Smith heater system installed in the new Vauxhall Velox consists of a large square chamber on the engine side of the bulkhead, connected to a circular duct from the radiator grille,

New Delco-Remy heater unit and blower

and fitted with a control flap. With the air-control open and the water control shut, air passes unheated to the windscreen, and through the scuttle ducts to the body. The flow can be increased by switching on the fan. If water is admitted to the heater radiator and the air control shut, the air from inside the car is circulated through the heater and the screen slits. With both air and water controls open, air is heated before passing through the scuttle ducts and the temperature can be regulated by operating the water control. De-mist air remains cool, and at very low speeds the fan may be used to boost the flow of air.

The duct leading from the front of the car to the heater unit is of large diameter and if the car is supplied without the heater radiator fresh air passes to the screen and through the scuttle ducts to the body. The flow can be boosted by the fan.

The Delco heater is a recently introduced unit which is suitable for pump- or thermo-circulation. A fan is fitted behind the heater radiator, and the central switch has five positions, giving two speeds in either direction, with the off-position between. In the two HEAT positions air is circulated through the heater core to provide direct heating of the interior of the car. In either of the two MIST positions warm air, in addition to de-misting the windscreen, is directed through the rear of the heater case and diffused by the scuttle, passing downwards through deflecting louvres. The volume of air can be adjusted in each case by varying the speed of the fan.

There is a tendency to regard the car radiator as an inexhaustible supply of heat, which may be drawn upon in any quantity and under any conditions. Over-cooling of the engine actually occurs in certain circumstances with some of the present installations. The average heat lost to the jacket water is about equal to the thermal equivalent of the power developed by the engine, and the radiator will receive slightly less than this by the amount radiated from the jackets and pipes. The radiator, however, must be capable of dealing with the maximum heat produced by the engine under arduous conditions such as when operating on full throttle on a low gear. A thermostatic by-pass is generally fitted between the engine and the radiator, but if a further three of four kilowatts in heat is taken from the jacket water, it must result in a reduction in the working temperature. If the temperature falls in consequence, the three of four kilowatts will be correspondingly reduced until a balancing temperature is reached, but unless the heater unit is only allowed to take in a quantity of heat, which is small in comparison with that delivered to the jacket water, it is difficult to see how the working temperature can be maintained. The circumstances under which this could happen would probably have to be very severe and abnormal, but nevertheless it is a factor which appears worth taking into account in the original design.

Horizontal features predominate on the front end of the new Vauxhall Velox

BODYWORK

Some Outstanding New Designs by British Manufacturers

AFTER five years during which British manufacturers have been seeking to establish a reputation in dollar markets, it is only natural that the influence of American styles should be very marked in new designs at the Motor Show. Opinions have been expressed that the first attempts to emulate Transatlantic designs in the early post-war years were crude. However, judging from the appearance of the new and modified products of the home industry, it seems that a happy compromise between the British and American styles has been found. This compromise, it is hoped, will appeal to the majority on both sides of the Atlantic.

With regard to front ends, emphasis is placed on horizontal features by most manufacturers of cars in the popular price range, and wide radiator grilles of more or less rectangular form predominate. The new Vauxhall Velox and Wyvern and the modified Standard Vanguard are examples of this trend. Even in the case of the Austin Hereford and Humber Hawk and Limousine, the vertical radiator grille effect is offset by secondary horizontal grilles just above the front apron. These grilles are used by several manufacturers to furnish an entry for air cooling the front brakes, and for body ventilation purposes. In the higher-priced range the traditional vertical radiator, together with appropriate headlamp arrangement and front wing form, is favoured.

The advantages of slab sides in providing clean aerodynamic exterior lines and permitting good seating arrangements, have not been overlooked. On the other hand, the one disadvantage of this style, namely its very plain appearance, has been cleverly overcome. Many visitors to the Exhibition probably went away with the impression that no slab sides were shown. This effect, in general, has been obtained in two ways. Rubbing strips and mouldings are appropriately positioned to break up the plainness of the sides; and wings, door panels, and rear quarters have been pressed to give a suggestion of the old style of separate wing. Although shallow and of streamline form, these pressings have well-defined boundary lines to give the desired effect. Apart from the aesthetic aspect of this measure, it is very beneficial in reducing panel drumming.

Even the coachbuilders making very costly limousines have modified the traditional wing form so that it blends into the body and, together with a long, sweeping, streamlined shape, conveys the impression that it belongs to an age of speed and efficiency. The knife-edge style in many cases has been replaced by a modified knife-edge with somewhat more rounded features. In this class of vehicle head, side and fog lamps blended into the wing and front end lines are the vogue.

At the rear end, twin tail lamps would appear well established except on the small economy cars. On the modified Rileys the twin rear bumpers are spaced to permit the withdrawal of the spare wheel between the two bars. By virtue of this arrangement the wheel compartment can be set lower than hitherto without having a detrimental effect on either the bumper position or the ground clearance. Another advantage is that some measure of protection can be afforded to the tail lamps. Careful design is necessary, however, to ensure that, in splitting the bumper and making it in several pieces it has adequate effectiveness and strength.

Most manufacturers have devoted attention to the better arrangement of the boot, particularly by improving the general interior shape and by the clearing of obstructions. One of the best examples of this is the new Vauxhall. In a chassisless design it is often as easy to mount the petrol tank vertically in a convenient space as in the more usual position under the boot floor. A two-fold advantage can be gained, namely the filler tube need not intrude into the luggage space, and the under-floor position is left free for the spare wheel. A separate compartment for the wheel, permitting it to be withdrawn without removing the luggage, is now regarded as an essential, even in inexpensive cars.

Interior appointments are little changed. There is a marked tendency to group all instruments close together for quick and easy reference. Two dials, and in some cases only one, incorporate all the necessary instruments. The new Austin Seven has, perhaps, one of the simplest instrument arrangements. A feature that may well gain in popularity is the moulded plastic facia in the new Vauxhall cars.

Seats are almost invariably padded with foam rubber, and armrests on the doors are very popular. It is notable that some of the bench type seats have squabs shaped to give lateral support in the same way as bucket seats. This arrangement need not preclude the possibility of seating three abreast. Examples are the front seat of the A.C. Buckland sports tourer, and the rear squab of the Austin Seven, although in the Austin the shape was primarily introduced to furnish clearance for the shock absorbers mounted behind it on each side.

Austin Seven four-door saloon

Many manufacturers are not at present fitting sliding roofs. For headlining, plastic covered cloth is being introduced. An essential characteristic of material for this purpose is that it should be elastic, so that it can be made to conform with the roof shape. Its principal advantage is that it is washable. Among convertible models, power-operated heads seem to be gaining popularity. Examples of this feature were to be seen on the Lancia Fourteen, the Ford Zephyr,

and the Austin Hereford tourers. Curved windscreens and rear windows are commonly fitted, and so are hinged ventilating panels, which are standard on many cars. There were one or two examples of moulded rubber front floor coverings.

Larger and more efficient heaters are being used, the fresh-air type predominating. Many are arranged so that recirculated air can be used for de-icing, the change being made to fresh air when de-misting only is required. Windscreen washing jets are very popular as an additional extra.

The Austin Seven, by virtue of its relatively low price coupled with attractive lines and other excellent qualities, aroused great interest. The suggestion that it is a scaled-down version of the Hereford is an oversimplification that is misleading. Certainly, this four-door chassisless vehicle bears a remarkable resemblance, as far as style is concerned, to the Hereford. The outstanding features of this design are the economy of space and the ingenious ways in which manufacturing cost has been kept down. Furthermore, credit is due to those who have so successfully attained such pleasing lines in so small a car.

A chromium-plated radiator grille that has, since the last war, been characteristic of the popular-priced range of Austin cars, is somewhat unusual in that it is a pressing instead of the zinc die-casting more common to such small grilles. A full-width chromium-plated front bumper of a simple curved cross-section is fitted, and closely resembles that at the rear. Further economy, in both material in short supply and in production cost, has been effected by the use of a bonnet latch made with pressed steel parts to replace zinc die-castings. This mechanism functions in a similar manner to the Hereford bonnet catch, being operated by lifting the "flying A" motif. The bonnet top itself is of very light construction, and therefore needs no spring balancing on the concealed hinges which are of the single-centre single-link type. A simple prop mounted on the lid is provided to hold it in the raised position. The hatch type of bonnet opening, which is another feature similar to the Hereford, is reinforced around its edge by the drip channel. This is undoubtedly the simplest, strongest, and stiffest possible form of bonnet construction. Detachable front wings are fitted with torpedo-type sidelamps mounted on their crown. It is therefore possible to see whether the sidelamps are on and the driver has an accurate indication of the wing position. Lucas type 700 headlamps are situated in the front of the bonnet surround.

Mounted at the front edges of the doors, the well-spaced external hinges have their leaves inside, instead of being recessed into, their respective pillars on the body and on the door. This rather unusual feature gives a continuous flat surface around the door and the door openings. In conjunction with the usual double seal, this should provide very efficient dust exclusion.

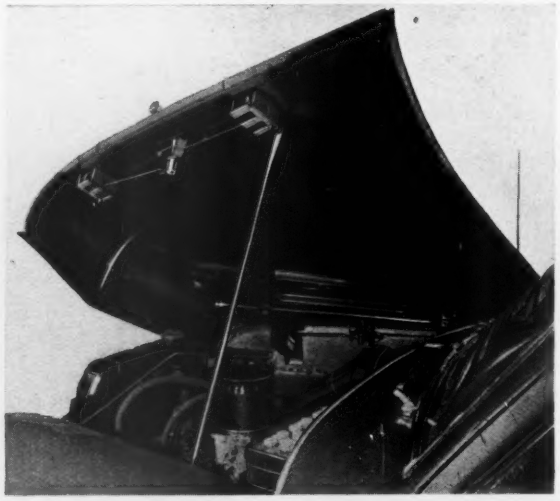
In the front door, a balanced-lift mechanism supports the window on which is a glass finger lift. On the rear door there is a fixed glass and hinged ventilating panel. Trouble has been experienced in the past with water leakage at the pivots of hinged ventilating panels, since at these points it is necessary to incorporate a break in the rubber flange of the frame. On the Austin Seven continuous grooves are incorporated, adjacent to the edge of the glass of the hinged panels, around the rubber. Water can then be drained away, through holes moulded in the rubber, from the groove to the interior of the door instead of passing into the saloon.

An H-section plastic beading supports the grained millboard trim panel, in a suitably shaped hole in the inner door panel, with the horizontal part of H separating the edge of the trim panel from that of the door panel. The same method is used to mount the trim in the inner rear quarter panels. With a very small car the utmost ingenuity is called for to keep the interior free of obstruction in order to make the fullest use of the space available. With this end in view, the inner faces of the doors have been kept free of all handles and other projections. This has been effected by the use of the balanced window-lift mentioned before, and by fitting a plastic pull-to on the top edge of the waist rail, together with a lever-type combined door and window lock.

The door is unlatched by moving the lever in one direction in the fore-and-aft plane, and movement in the other direction locks both the doors and the windows at the same time. When locked, the windows may be lowered about $\frac{3}{4}$ in for ventilation. Another notable feature of this design is that the rotating-type exterior handles are mounted on a square shank, the inner end of which is drilled and split to take a self-tapping screw. This expands the shank, locks itself, and takes up all clearance between the shank and its hole, thus eliminating all possibility of rattling.

Covered by the door, the rocker panel is pressed as part of the rear quarter panel which is formed to give a rear wing effect. The boot lid

The Austin Seven boot lid is swung back bodily on spring-balanced links



The Vauxhall bonnet lid can be raised from either side or removed completely

Daimler Regency six-seater saloon

extends to the rear canopy. This arrangement eliminates a soldered joint here, the quarter panel being attached to the canopy by a spot-welded right-angle flanged joint. In fact, there are no soldered joints anywhere on this car. It is necessary to swing the boot lid to the rear and upwards to clear the rear canopy. This is effected by the usual spring-balanced concealed hinges made up of suitable links. By hinging the lid at the top no handle is needed, its place being taken by a pressed beading at the bottom edge. Furthermore, it is impossible to overload the car with luggage by piling it on the lid, as is the case when the hinge is at the bottom. A square-section key operates the boot lock above which is the number-plate which is illuminated by the rear lamp. The spare wheel is housed vertically in the boot against the rear of the seat squab.

Inside the car, a further saving of space is effected by the use of bucket-type front seats, which give maximum knee-room at the back. Furthermore, the swinging-link type seat supports, with a U-shaped locking bar, are so arranged that the floor under the seats is clear and gives extra foot and leg room. Dunlopillo latex foam is used on all squabs and seats. The rear seats with shaped squabs are between the wheel arches which are used as arm rests. In the roof, the head lining is mounted on a metal frame which fits behind a rebate at the cant rails. This ingenious arrangement eliminates all timber and tacking from the assembly process. The rubber moulding for the flat rear window serves also as a finisher for the surrounding head lining, which is stuck to the edge of the hole.

A plain, painted facia is used with a central detachable instrument panel in full view of the driver. It houses a single instrument incorporating the speedometer, petrol gauge, and oil warning lights. To the right of the instrument a trafficator switch is fitted below the windscreen wiper control, and to the left are arranged the knob type ignition switch and an ignition warning light. At the top of the fixed part of the facia is a central ash tray, and below the instrument panel and to each side of it, are the choke and starter. There is an open cubby hole on each side, one of which houses the optional extra Radiomobile equipment for which there is a roof aerial. Provision is made for a recirculator heater on the dash. The lights are switched on by rotating a star shaped knob mounted on a suitable bracket bolted at right angles to the steering column.

The new Vauxhall Velox and Wyvern models, of integral construction, are available in a wide range of colour combinations. Whilst closely following the current trend of American styles, they nevertheless avoid features that, on this side of the Atlantic, are apt to be regarded as somewhat exaggerated. A light and pleasing appearance has been given by the general arrangement of the bumpers, radiator grille, and lamps. Lucas double-dip head lamps and separate parking lights are fitted.

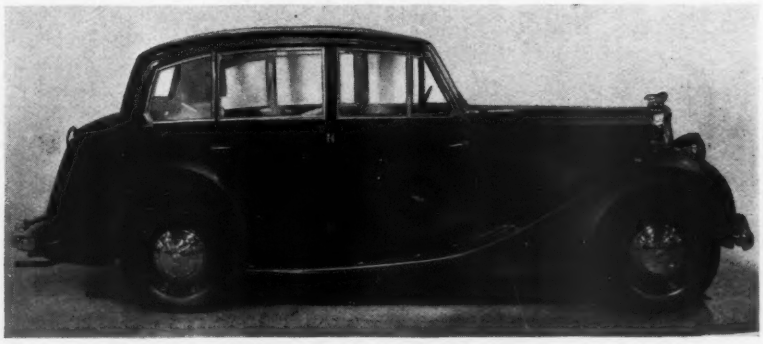
Features emphasizing the width are characterisitic of the front end which has, above the bumper, a wide rectangular grille with rounded corners. The alligator-type bonnet has a spot-welded flange joint down its crown line and incorporates the usual Vauxhall chromium-plated flutes. A pressed steel lip on the lid, below the motif, preserves a clean bonnet front opening line.

A feature of the bonnet lid is that, having hinged latches at both sides, it can be opened from either side and propped. On the lid and adjacent to each wing is a chromium-plated button, and by lifting this a square shank is withdrawn from a socket. It is then hinged over at right angles, so that it may be turned to unlatch the mechanism. By unlatching both sides, the lid can be removed completely. It gives extremely good accessibility to the engine, although the lid is slightly heavier to open than is usual with spring-balanced hinges.

As viewed from the side, smooth flowing lines are provided by the bonnet, raked screen, roof and boot layout, and by the continuation of the front wing crown line from the head lamps through the waist rail to the extreme rear. Here, the unusually large tail lamps, together with suitable plastic mouldings that conceal tooling holes, complete the streamlined effect on each side.

Rubbing strips at the front, chromium-plated on the Velox, and the same colour as the car on the Wyvern, and wing pressings at the rear completely relieve the slab-sided effect. The strips extend from the head lamp to the centre of the front door. At the rear this line is introduced again by the top of the wing, which takes the form of a pressing in the rear door and in the quarter panel. Its top line extends from the centre of the rear door to the centre of the rear lamp. The need for a rear apron is obviated by a forward extension of the horizontal top face of the bumper.

A capacious boot is formed by the extended rear end of the car. The lid, with spring-balanced concealed hinges at the top, is automatically raised to the full open position by pressing a button on the heel board. A fixed, pressed-steel handle, fitted with a horizontal chromium-plated motif, is used to



The Triumph four-cylinder Limousine

Lanchester convertible with the hood in the de Ville position

lower the lid. The handle also houses the lamp illuminating the number plate on the lid immediately below it. An outstanding feature of the boot is its unobstructed floor. The petrol tank is mounted vertically behind the seat squab which is positioned well forward. The short filler tube extends upward from the top of the tank to the rear quarter panel. It is fitted with a plain, disc-type steel cap that is spring-loaded and flush with the panel. Finger pressure on the hinge side of the cover causes it to spring open, and pressure adjacent to the latch closes it again.

A few turns of a bolt recessed below the boot floor lowers the spare wheel on its spring-balanced cradle to a position from which it may be removed easily. Fitted with a rubber plug, a small hole in the floor gives access to the spare wheel valve for checking and pumping up the pressure. The jack is housed in a clip behind the left hand wheel arch and a tool box is fitted between the boot lid hinges adjacent to the rear canopy.

Fixed exterior door handles are fitted at the waist-rail, where they are protected from accidental damage owing to the fact that they are well within the overall width of the body. Placed on each door for thumb operation as the fingers grip the handles, is a press button to release slam-type locks. Button-type releases are also fitted inside the doors immediately below the chromium-plated pull-to handles. A Union lock is fitted to both front doors. They are unlocked from the outside by the ignition key, but can only be locked by moving the interior slide catches before closing the doors.

Hinged ventilating panels of the reversible type are fitted to the front doors only. These, together with fixed triangular panels on the rear doors give two straight edges on each door to carry guide channels for the balanced-lift type windows operated by glass finger lifts. The windows can be locked fully up, or one inch down for ventilation in hot weather. Both the screen and the rear windows are of curved glass giving an excellent range of visibility. Twin windscreen wipers of the self-parking type are fitted. They are operated from the camshaft and are designed to slow down before reversing at the end of each stroke, to give a smoother and quieter action.

Inside the car, ample leg room is provided by the increased wheelbase of 8 ft 7 in, and by the forward positioning of the engine. The adjustable bench-type front seat is 56 in wide. Armrests for both front and rear seats are fitted to each door. On the Velox only, there is a folding armrest at the centre of the rear seat which has a width of 57 in. This width has been obtained by the forward positioning of the seat, coupled with an increase of 1½ in on the rear track as compared with that at the front. The increase has been made possible by pressing the rear quarter-panel to give a wing form which, with its generous wheel opening, gives ample clearance for snow chains. It is remarkable that these two models, in spite of their larger size, only weigh 60 lb and 110 lb more than the previous Velox and Wyvern models respectively.

The facia is of Dyacon plastic, moulded in relief and metal-sprayed at the back. Over the two spokes of the steering wheel, the driver has an unobstructed view of the two round instrument dials. The one to the right contains the speedometer and head lamp beam indicator, whilst in that on the left are the fuel gauge, thermometer and the oil and ignition warning lights. Three vertically disposed knobs to the left of the dials control the radio mounted behind the panel. The speaker is fitted on the inside of the glove box lid, which is opposite the front passenger's seat. Controls for the starter, choke, ventilation, windscreen wipers and washing equipment, as well as the lights, are all carried on a chromium-plated panel, mounted below the centre of the facia. The

Re-styled grille on Standard Vanguard

Radiator grille on Healey convertible

Binnacle type instrument mounting on Ford Zephyr convertible

Glove boxes have pivoted, disappearing lids on Simca Aronde facia

horn push and trafficator are both carried on the steering wheel boss.

A notable feature is that all optional extras including radio, heating, windscreen washing equipment, fog lamps, and towing attachment, have only to to bolted on; the wiring, pipes and controls are in position in all cars when they leave the factory, and only need to be connected when the accessories are added later. The radio is made by Plessey Ltd, to Vauxhall specifications. Full-width screen de-icing is provided for by using the Vauxhall-designed heater as a recirculator. De-misting is effected when the heater is operating as a fresh-air type unit. Incorporated in the bearing heads for the wiper spindles are jets for the windscreen washing equipment.

The new Daimler Regency was undoubtedly one of the attractions among the luxury vehicles. It is characterized by sweeping contours and a flowing wing form. Furthermore, the bonnet line, and the way in which the forward-positioned lamps blend into the wing are styled to be suggestive of speed. Of particular note is the side lamp housing, which runs into the crown line of the wing, this being a great improvement on previous models. Two foglamps are standard equipment, being fitted below the Lucas 770 headlamps in the forward facing part of the wing fillets.

The front bumpers, with overriders, are of simple yet serviceable design and are fitted with a narrow apron which overlaps that on the front of the body. At the rear, similar bumpers are used, but with an apron on the bumpers only. As in last year's Consort, the radiator has slightly more curvature and rake than has been used in the past by this manufacturer. However, it retains the characteristic appearance associated with the well-known fluted radiator and is in harmony with the modern styling of the car. The bonnet lid, hinged at the centre, is released by a knob under the facia.

With a sharply defined crown line to obviate any tendency to a bulbous appearance, the front wing is a good example of tasteful adaptation of the traditional style to modern requirements. Its general streamlined shape is continued to the middle of the rear door, where is sweeps sharply upwards to blend into the streamlined rear wing shape. Both wing cutting lines are formed by fairly generous rounded curves.

The windscreen is curved in one plane and is fitted with a chromium-plated frame. At the top of the windscreen pillar a flanged butt joint is incorporated to permit a certain amount of movement without fracture of the pillar. No welding is employed at the joint, the two pieces being held together at the junction by the inner structure.

At the rear end, stop and tail lights of the cheese-dish type are fitted in each wing. Illumination of the number plate on the boot lid is provided for by a bulb in the housing for the reversing light. Just to one side of this housing is the boot lid handle incorporating a lock. Each hinge at the top of the boot lid is spring-balanced by hairpin-shaped torsion bars. These act through over-centre toggle levers in such a manner as to hold it firmly down; and when lifted, to support it in the open position. The spare wheel and tools are under the luggage platform, and can be removed easily, without unloading the contents of the boot. The full-width rear window is curved in two planes.

The doors, with concealed hinges at their front edges, have a thin, painted waist-line extended to the front and rear ends of the car. Handles with push-button releases are used outside the doors, whilst inside are rotating type handles. Chromium-plated brass extruded sections are used for the window frames. Drop windows are fitted in the doors, and are operated by the usual winding mechanism. In the front doors ventilating panels, hinged near their front edges, are fitted. The rear quarter windows are hinged in the same manner but, being situated further outboard than those at the front, their opening is restricted to avoid breakage. Around each door, with its window frame, is a rubber dust excluder. A draught welt is fitted all round the door opening. A notable feature is that the door pillars, and some of the other structural members are made of light alloy castings instead of the more usual timber. The steel panels are flanged around these members and where necessary are further secured by Parker Kalon screws. The usual check holding the door when fully open is incorporated, and a deep groove in the top of the waist-rail forms the pull-to. A hinged flap with gusset sides covers a cubby-hole on each door. It is fastened by a press stud at the top, an arrangement which gives it the appearance, when closed, of being a pocket. Armrests, adjustable for height, are fitted at the front.

The front seats, with a centre armrest, are of the separately adjustable, split-bench type. Being almost clear of the wheelarches, the rear seats have armrests which are, in side view, of a somewhat elliptical shape, and which have cylindrical ashtrays that telescope into their front faces. A folding armrest of the usual design is fitted at the centre. Hide is used throughout for trimming and upholstery.

Polished walnut veneer covers the facia and the waist rails, as well as the front and rear pillars. Situated in the centre of the instrument panel is a large dial for the trip-speedometer above which is an ashtray. Set vertically to its left are the petrol gauge and clock, and similarly arranged to its right are the ammeter, and water temperature gauge. The oil pressure, and ignition warning lights are below the speedometer. On the extreme right of the instrument panel is the ignition switch, and a four-position lamp switch for the head, side, and

Hinged head rail and front roof stick on Frazer-Nash

fog lamps. A warning light on each side indicates when the appropriate trafficator is in use and another warning light gives a dull glow when the headlights are undipped. Controls are fitted for the twin electric windscreen wipers, reserve petrol supply, starter, throttle and mixture, and a rheostat switch controls the panel light. Taking its air supply from the scuttle vent, the Clayton-Dewandre heater, which has a separate fan for de-misting, has a water control, a rheostat fan control, and an air shutter. The scuttle vent opens to the rear where it is in area of comparatively high air pressure. It is fitted with a gauze and a water-trap drained to the outside of the car. Provision is made in the lower part of the facia for a radio, the aerial being in the wing. One speaker is housed on the headrail behind the lining cloth, and an additional one can be installed under the rear parcel shelf.

As far as external appearance is concerned, there is very little difference between the Triumph Renown and the Limousine. The wheelbase has been extended 3 in to make room for a partition at the squab of the fixed front seat.

The Schuntzer door locks are fitted with push buttons outside and the usual rotating handles inside. When the door is opened wide, it is retained in that position by the door-check. The rear door windows are prevented from winding more than half-way down by the intrusion of the wheel arch, but the front ones will drop down to give a full opening. Hinged ventilating panels are fitted to the front only. With chromium-plated frames of small section around the windows it is only possible to fit single dust seals around the doors. However, this need be no disadvantage for, if well fitted, a single seal is often more effective than a double one. Pockets are on all four doors, and on the front doors are armrests, adjustable for height.

THE PARIS SALON

A special detailed report of the 1951 Paris Salon will appear in the issue for December, published December 13th. It will constitute a survey of the more interesting designs, with an indication of bodywork trends.

Copies may be obtained by order from newsagents throughout the United Kingdom, price 3s. 6d. net. It is still necessary to remind readers that a definite instruction should be given to the newsagent to make certain of securing a copy.

At the rear, armrests are on the wheel arches, and in addition a centre armrest is provided. Dunlopillo on a deep spring base is used for all seats. On the back of the partition forming the squab for the fixed front seat is the Smiths radio in a polished walnut case, the speaker being mounted under the parcel shelf behind the rear seat. A speaker extension to the front compartment can be supplied as an optional extra. Above the partition waist rail of walnut are two flat sliding windows of toughened glass flanked on each side by fixed curved ones. On the roof of the rear compartment is a very attractive festoon type of lamp.

Polished walnut is used for the waist rails which extend the full length of the sides to merge into the facia of the same material. The scuttle vent, operated by a lever below the facia, supplies air for ventilation and for the Clayton-Dewandre heater situated on the dash.

The knife-edge style naturally forms a very convenient rectangular-shaped compartment for the luggage. Two handles, one incorporating a lock, are furnished for the boot lid. Provided the side lights are on, the lamp inside is automatically switched on when the lid is opened. In fully open position, the lid can be locked down, by a square section key, with the inner face flush with the floor to furnish a steady platform to carry a trunk. The same key unlocks the inner panel of the deep lid in which is housed the tools and spare wheel.

(*To be concluded in December issue.*)

Wing mounting of petrol tank on Fraser-Nash drophead coupé

Inclined squabs and large, thigh-supporting cushions on Ford Comète